JUNE 1953

# MECHANICAL ENGINEERING



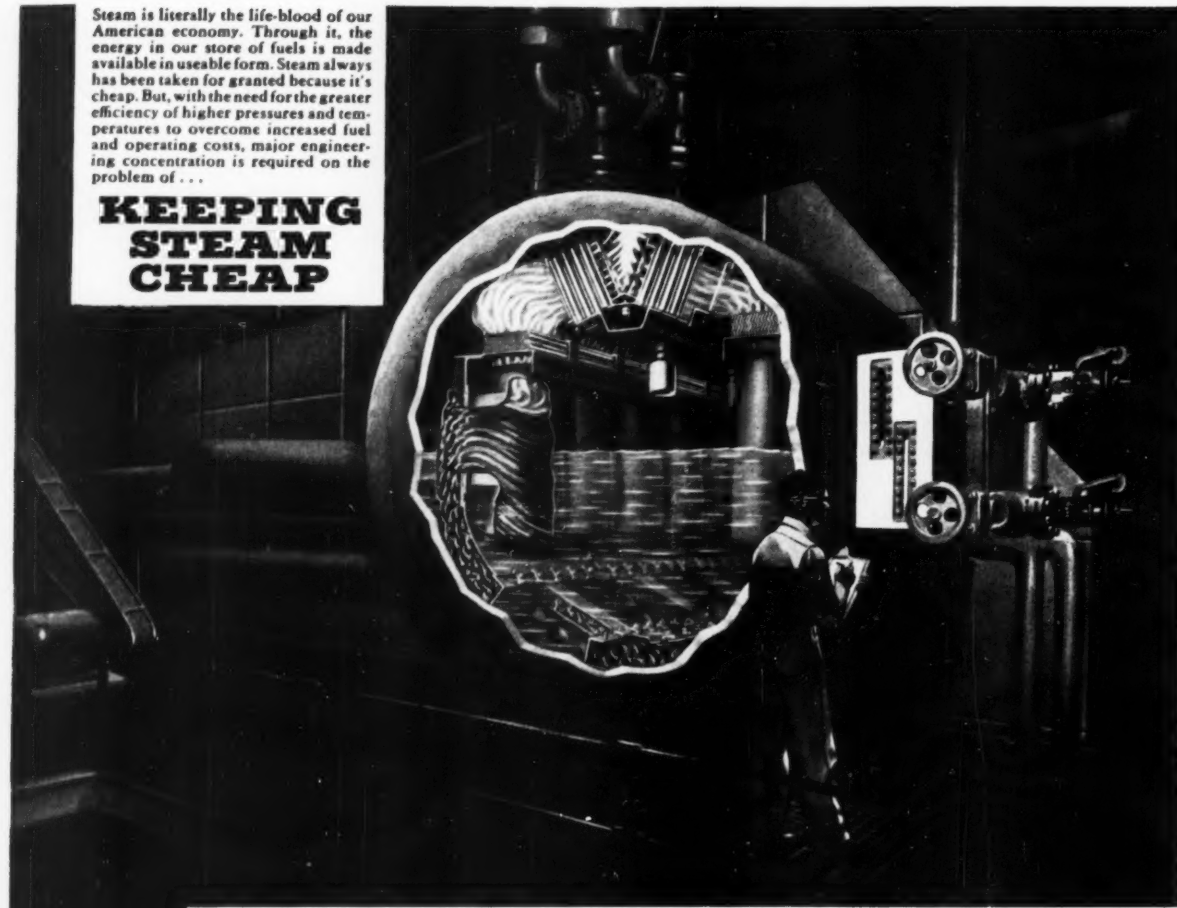
**Departments**



**ASME Semi-Annual Meeting — Los Angeles, Calif., June 28-July 2, 1953**

Steam is literally the life-blood of our American economy. Through it, the energy in our store of fuels is made available in useable form. Steam always has been taken for granted because it's cheap. But, with the need for the greater efficiency of higher pressures and temperatures to overcome increased fuel and operating costs, major engineering concentration is required on the problem of . . .

# KEEPING STEAM CHEAP



## B&W CYCLONE STEAM SEPARATOR

### . . . A key to greater fuel economy

Economy-minded public utility and industrial operators of steam generating equipment, together with boiler manufacturers, have striven for years for higher pressures and temperatures necessary for greater fuel economy. At higher pressures, however, steam and water are harder to separate, making it more difficult to get good circulation and to obtain the clean, dry steam needed for top turbine performance.

Thus, the benefits promised by higher pressures were being blocked by the threat of poor circulation and by increased carryover of moisture to the turbine—resulting in loss of turbine efficiency and increased down time for cleaning and maintenance.

With one step, this barrier to the benefits of higher steam pressure was removed when B&W engineers developed the Cyclone Steam Separator, a small, simple, *stationary* device with no complications or moving parts. Located *inside* the steam drum, the Cyclone—offered only by B&W—utilizes circulating energy to cause the moisture to *whirl* out of the steam. *Clean, dry steam* is sent to the superheater, and *dense water* is sent back to assist in circulation.

Thus, users of B&W boilers, long before any others, were able to enjoy the economy of higher steam pressures. Today, there are more than 75 B&W natural circulation boilers in operation or under construction for pressures of 2000 psi and up. Some have 15 years of service behind them, and one unit with a design pressure of 2650 psi has been in continuous central station operation for 12 years.

Bringing greater economy to users of steam by constant improvement of all the elements in steam generation is the guiding factor behind B&W's Research and Development program.

N-152

**BABCOCK & WILCOX**

BOILER DIVISION

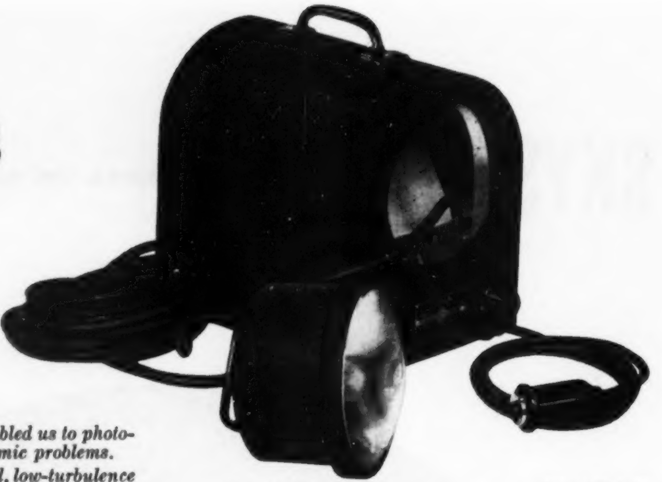
MECHANICAL ENGINEERING, June, 1953, Vol. 75, No. 6. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢ Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

 For Editorial Contents See Page 443 

# Visual Aerodynamics

**with the GR Type 1532-B**

**STROBOLUME**



Indicative of the versatility of the G-R Type 1532-B Strobolume is an unusual method for the visualization of air flow, described by Prof. F. N. M. Brown, Head of the Dept. of Aeronautical Engineering at the University of Notre Dame.

*"This short-interval, high-intensity flash source has enabled us to photograph and study a wide variety of fundamental aerodynamic problems.*

*Briefly, the technique employs a small, easily-constructed, low-turbulence wind-tunnel with a transparent working section in which the model is placed. Smoke produced by the coking of grain straw is introduced just upstream of the antiturbulence screening. It flows with the air stream over and around the model at speeds ranging from fifteen to one hundred seventy-five feet per second.*

*The Strobolume's short duration white flash is 2000 times as intense as the flash of an ordinary stroboscope. The instrument permits single-exposure still photography of periodic aerodynamic phenomena whose frequencies may range as high as six thousand per second. This is accomplished with conventional camera equipment and lens aperatures as small as f/6.3.*

*Successful motion pictures of low frequency aerodynamic phenomena also have been made at rates as high as 64 frames per second. In this application the Strobolumes were tripped by a rotary switch driven by the camera motor."*

Studies conducted with the "visualization technique" have brought forth both facts and speculation which offer the imaginative aerodynamicist new material for thought.

For example, photographs of transitioning boundary layers, where transition is due to an adverse pressure gradient, reveal that actual vortices are formed and that the frequency is surprisingly regular. Study of unobstructed flow at various speeds shows that wind turbulence is not a constant, but is a function of speed, and that the decay time between screening at the end of the pressure chamber and the object under study is of greater importance than has been hitherto thought. Even casual inspection of photographic studies indicates the accuracy of the vortex theory and the long appreciated disapplication of Freude's analysis.

**Type 1532-B Strobolume . . . . Price $265.00**

**Short Flash** — *Each flash lasts only 40 millionths of a second at high intensity; 20 millionths at low intensity position.*

**Wide Speed Range** — *High intensity: up to 60 flashes per minute, continuous; up to 1200 for short periods. Low intensity: up to 3000 per minute, continuous.*

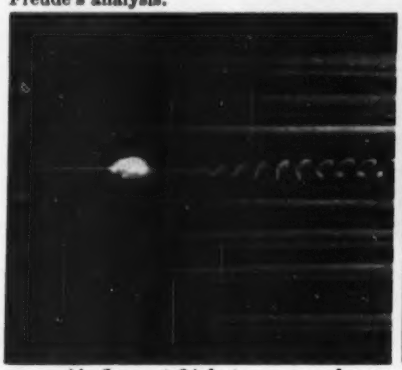
**Versatility in Operation** — *Can be flashed from an external contactor, such as G-R Type 1535-A Contactor, or from Type 631-BL Strobotac — Cable with pushbutton is provided for manual flashing.*

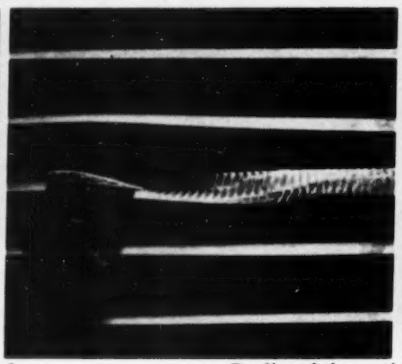
**Built-in Tripping Circuit** — *Any simple make or break device controls built-in Strobotron.*

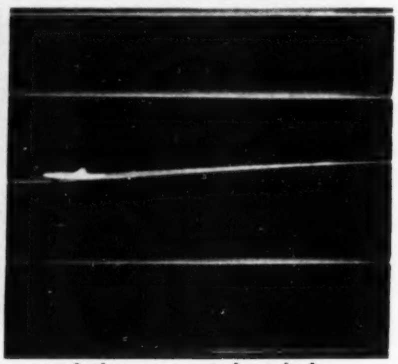
**Removable Lamp Housing** — *Lamp may be used at end of ten foot cable supplied, to reach otherwise inaccessible locations.*

**Safety Feature** — *Overload breaker opens circuit when maximum safe operating time is reached.*

**Compactness** — *7½ x 13 x 11 inches . . . 18½ lbs. overall, lamp assembly only two pounds.*







Air flows at 24 feet per second around a sharpened, flat plate. From such photographs, Mr. Brown has concluded that the vortex discharge is a function of the velocity to the three-halves power and of the length to the minus one-half power.

Studies of tip vortices reveal what appears to be a single, continuously-formed vortex of helical form having as its axis the core of the commonly recognized tip vortex. Inasmuch as a similar detail appears in the tip vortex of a sharpened, elliptical plan form plate, it is believed to be a part of every tip-vortex. The varying period and strength with tip form may explain the so-called "wing end drags" used by some German aerodynamicists.

**GENERAL RADIO Company**

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

*Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Geiger Counters ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators ☆ Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls ☆ Noise Meters ☆ Null Detectors ☆ Precision Capacitors ☆ Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters ☆ U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes*

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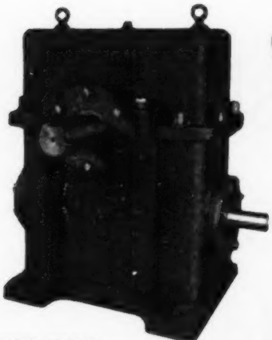
ESTABLISHED 1888



**TYPE "H" •**
Horizontal or Vertical Drive—Each drive type comes in 15 sizes, with ratio ranges of 5.6:1 to 100:1 and from .06 to 206 horsepower.

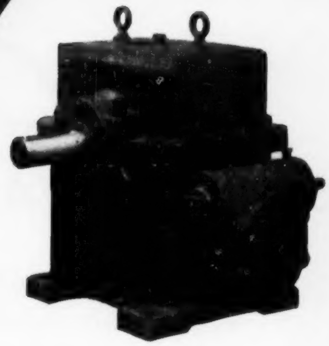
**TYPE "S" •**
Horizontal or Vertical Drive—Each type available in 8 sizes, ratio range of 5.66:1 to 100:1 and from .04 to 15.6 horsepower.

for the Best in

# WORM GEARS
AND
# WORM GEAR REDUCERS

**MOTORIZED •**
Horizontal or Vertical Drive—Each drive type comes in 11 sizes, has ratio range of 5.6:1 to 100:1, with ⅛ to 30 horsepower, driven speeds of 310 r.p.m. to 17.4 r.p.m. Vertical drive slow speed shaft extends either upward or downward.

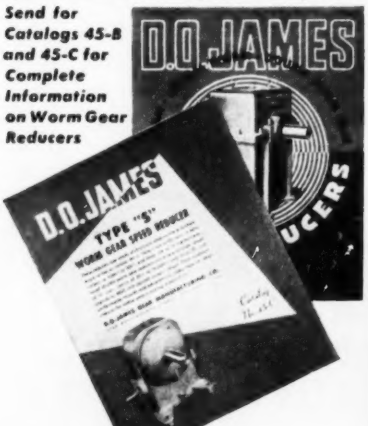
**DOUBLE •**
Horizontal or Vertical Drive—Each drive type available in 13 sizes, ratio range of 130:1 to 10000 and from .004 to 59.7 horsepower. Vertical drive slow speed shaft extends either upward or downward.



**WORM GEARS**
Generated on tangential feed hobbing machines by tapered and ground hobs. Made from 1" to 100" in diameter and from 24 DP to 1 DP.

***Catalogs*** are available to users of Gears and Gear Reducers—containing valuable engineering data, specifications, weights and prices.

***Send for Catalogs 45-B and 45-C for Complete Information on Worm Gear Reducers***




**D. O. JAMES Worm Gears and Worm Gear Reducers are designed and manufactured to have maximum inbuilt strength and to assure dependable *on-the-job* performance. The many and repeated installations of these reducers testify to their operating superiority and adaptability.**

**D.O. James GEAR MANUFACTURING COMPANY**
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Now you can measure or control the humidity of air or process gases with simplicity and accuracy never before obtainable!

An entirely new-type humidity-sensitive element, the exclusive Foxboro Dewcel*, opens many new possibilities for product improvement in industry. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

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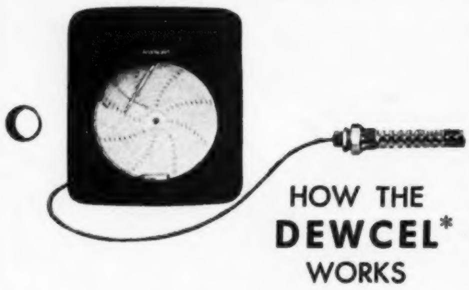
5. Simplicity that eliminates maintenance.
6. High sustained accuracy.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control for your process. In successful use in nuclear fission, pharmaceutical, food and chemical plants, distilleries, photo film production, drying and storage operations. Write for Bulletin 407. **The Foxboro Company, 966 Neponset Ave., Foxboro, Mass., U.S.A.**



## HOW THE DEWCEL* WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced gold or silver wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

**Trade Mark*

**FOXBORO**
REG. U. S. PAT. OFF.

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**INSTRUMENTS**

FACTORIES IN THE UNITED STATES CANADA, AND ENGLAND

## LADISH *Controlled Quality* ASSURES METALLURGICAL SOUNDNESS

**SPECTROGRAPHIC ANALYSIS**
One of many comprehensive Ladish laboratory test procedures for assuring reliable performance.


TO MARK PROGRESS

# Ladish measures the spectrum to verify chemical composition

**Metallurgical integrity—is safeguarded at Ladish by unsurpassed laboratory controls. Typical is this advanced electronic direct-reading spectrograph. On this unit as many as 300 determinations have been made in one hour to verify compliance of each mill heat with exacting Ladish specifications and, equally important, to assure the absence of detrimental "tramp" elements. Here is but one indication of the thorough, scientific procedures that assure reliability in every Ladish Controlled Quality fitting.**

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF . . . ONE RESPONSIBILITY

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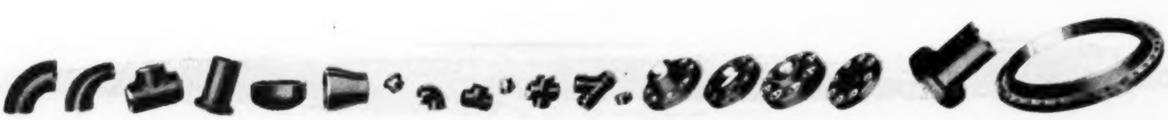
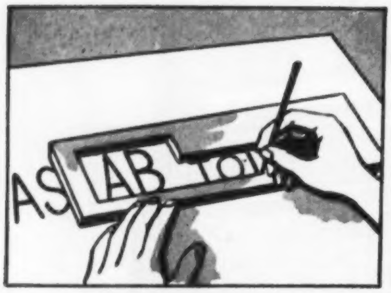
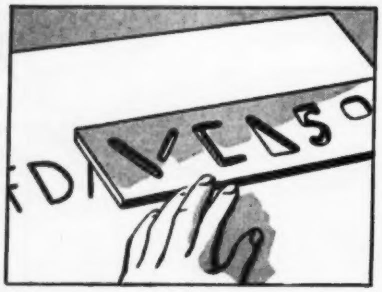


# From freehand to stencil
## ... this better way of lettering

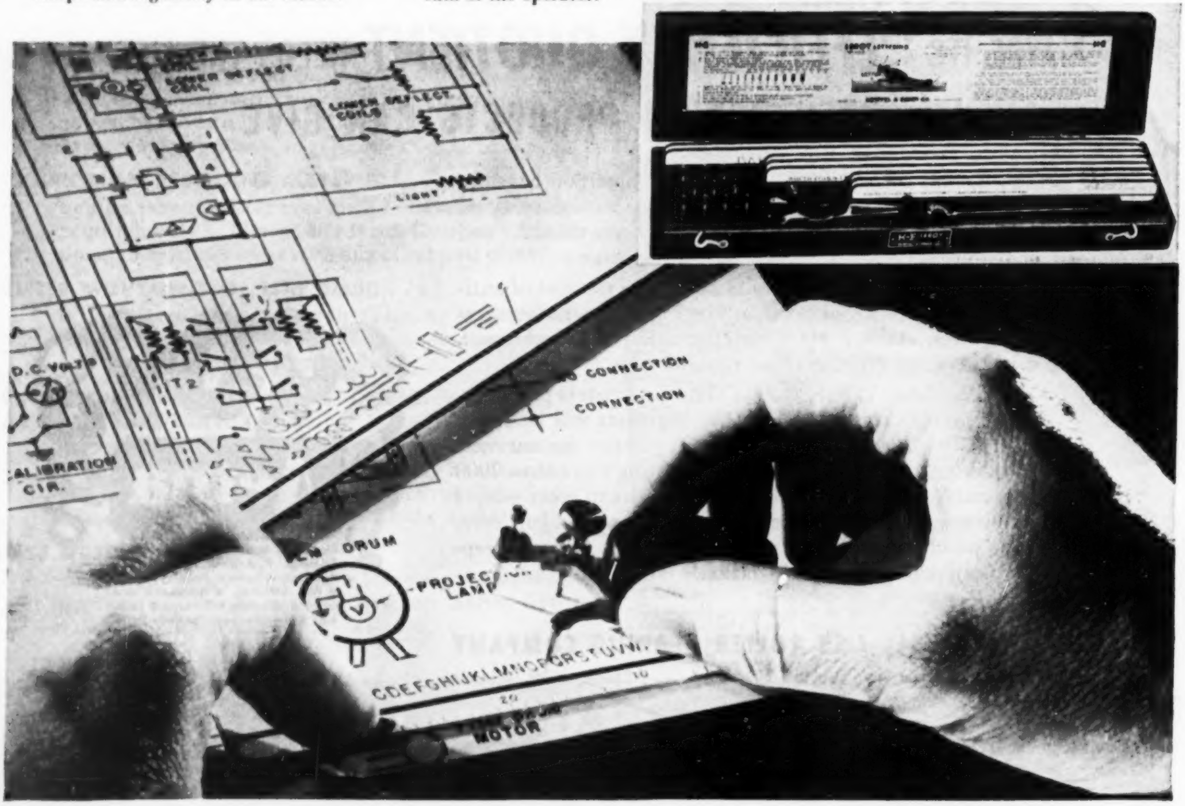



If the results of freehand lettering were always something to be proud of, there would be little or no need of special lettering aids. But as draftsmen know, freehand lettering is often irregular in appearance, and seldom can two men in a department letter exactly alike. Even as simple a device as a height guide helps considerably. Yet it fails in the important function of controlling the shape and regularity of the letters.

An obvious way of controlling shape as well as size is to use a stencil guide. To avoid the broken lines characteristic of stencils, guides were first devised consisting of cut-out portions of letters which could be combined to compose complete letters. However, they covered the work in progress, obscuring it from view, and the appearance of the finished lettering still depended largely on the skill of the operator.

To afford greater control, a stencil guide was developed on which all but a few letters were complete in outline. Shifting the guides with a shuttling motion permitted the breaks in the lines to be filled in. Like all stencils, these too covered up the lettering, and they also had to be supported slightly above the drawing surface so they could be shifted without smearing the work.




# Take a closer look at why Farrel® speed reducers can solve your drive problems

Unlike most "standardized" products, Farrel speed reducers are standard only in their principal features. They are adaptable in critical detail.

The gears and pinions can be proportioned to meet specific load, speed and service requirements. Input and output shafts can be varied in size, in material, and in extension. Even some housing dimensions can be modified to meet problems in mounting.

This design flexibility has resulted in the solution of innumerable application problems. There is no need to compromise. You can ask for—and get—a unit that will meet your exact needs.

Then, too, Farrel speed reducers are made in a number of different types, with a wide range of ratios and capacities. Designs include single, double and multiple reduction units, speed change units having two or more selective speeds, right angle drives, and drives to meet special requirements.

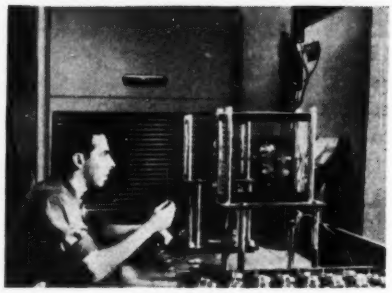
*Write for further details of these problem-solving units. Ask for a copy of Bulletin 449.*

**FARREL-BIRMINGHAM COMPANY, INC.**
**ANSONIA, CONNECTICUT**
*Plants:* Ansonia and Derby, Conn., Buffalo, N. Y.
*Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Memphis, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham®

FB-813

*Putting Air To Work For Kollsman:* When accuracy measures $\pm$ .0002, dirt specks and moisture are poison.



# CONDITIONED AIR

## KEEPS INSTRUMENTS ACCURATE 15 MILES UP

Airborne dirt and moisture are an expensive problem in assembly and testing of delicate aircraft instruments. But Kollsman Instrument Corporation found the economical solution. Fifteen Westinghouse Unitaire® Conditioners now process the air for an entire assembly floor.

By "zoning" this space, each UNITAIRE cools and dehumidifies its assigned area. This gives uniform air conditioning even though heat and moisture-producing operations on the floor vary. And Unitaire Conditioners are easily moved as production layouts change.

You can get the UNITAIRE now from your Westinghouse Air Conditioning Distributor's stock. Call him today. He's listed in the Yellow Pages of your telephone directory. Westinghouse Electric Corporation, Air Conditioning Division, Hyde Park 36, Massachusetts.

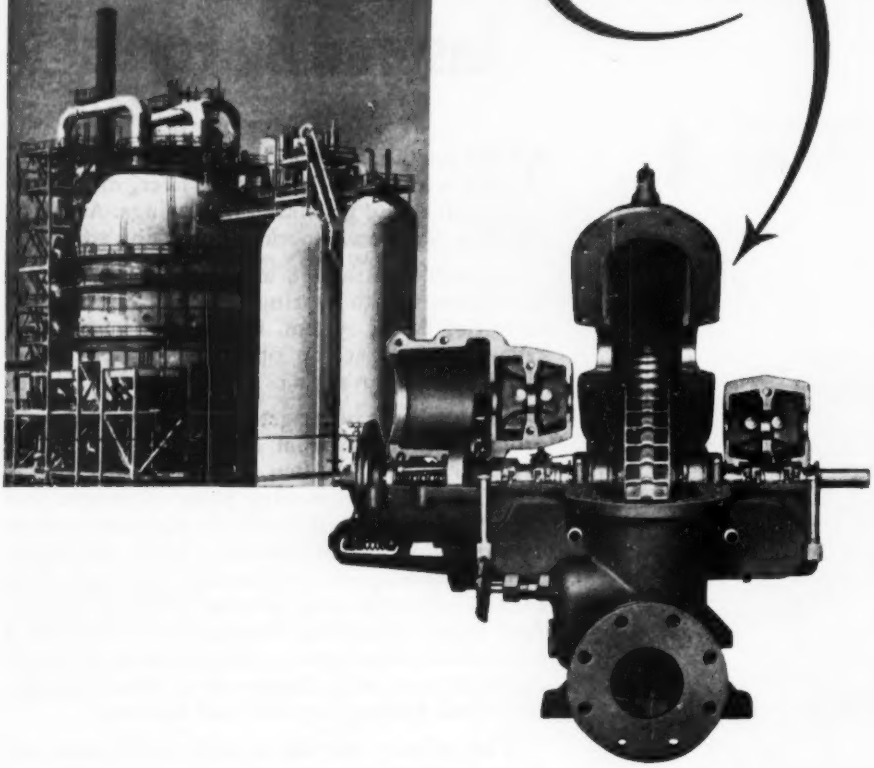
Where heat and humidity hamper skilled hands, a UNITAIRE gives constant temperature-humidity control. That's why Quinn Engineering Co., New York, has added ten more units to another Kollsman plant this year. Completely built by Westinghouse with its own proved parts, the UNITAIRE gives trouble-free service and economical operation.

## WESTINGHOUSE AIR CONDITIONING

YOU CAN BE SURE... IF IT'S Westinghouse

J-80310

# REFINERY has 101 ways to save money



When the yearly cost of replacement parts for 101 steam turbines averages *only 1.6% of the initial investment*, you are saving money . . . and plenty of it.

This amazing record was established by Terry turbines at a large refinery on the Atlantic coast. The percentage figure was determined by means of an accurate tabulation of the cost of replacement parts required over a two-year period.

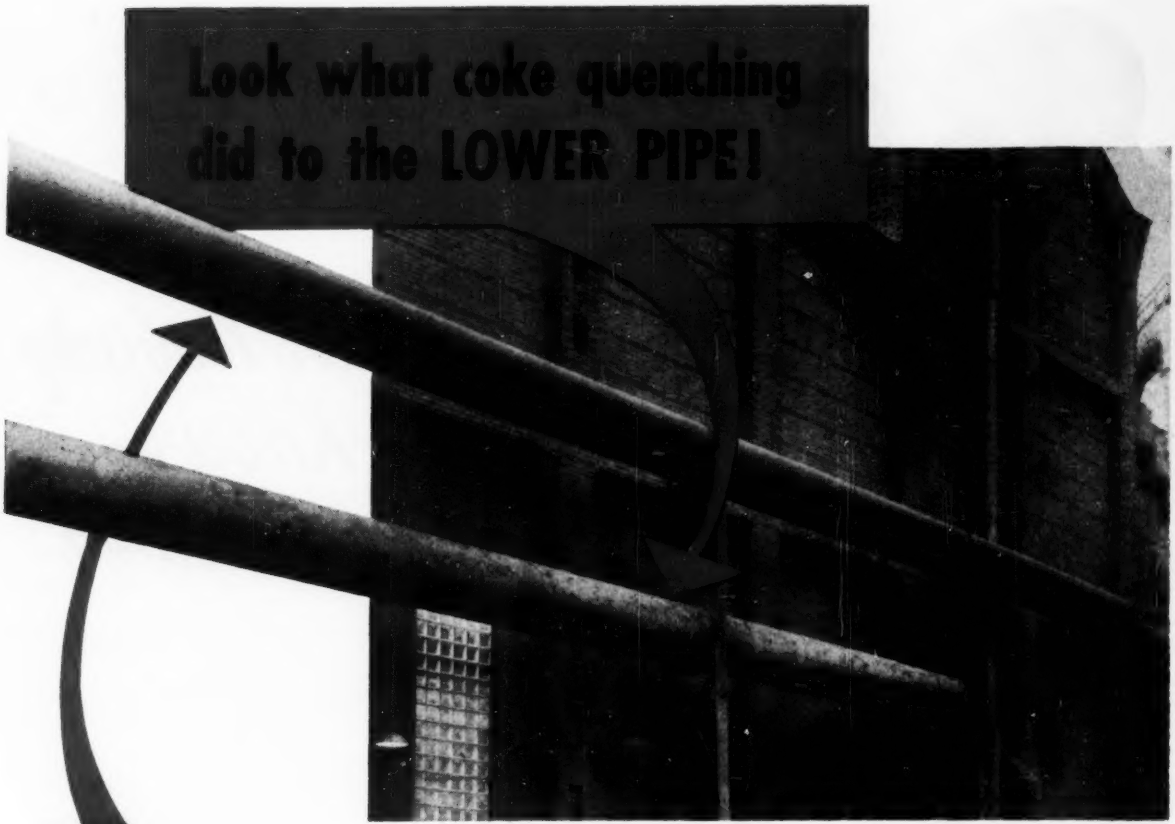
These 101 Terry machines provide a good cross section of the various types of small and medium-size turbines made by the company. Ranging in size from 10 to 1200 horsepower, they include single and multistage axial flow designs as well as the famous Terry solid-wheel turbine.

Such outstanding performance records are not at all unusual for Terry turbines. The thousands and thousands of these machines installed in refineries throughout the world provide an accurate yardstick for measuring turbine reliability.

*Send for illustrated bulletins. No. S-116 describes the many advantages of the Terry solid-wheel turbine. For multi-stage turbines, ask for a copy of Bulletin S-146.*

**TERRY**

**THE TERRY STEAM TURBINE CO.**
**TERRY SQUARE, HARTFORD 1, CONN.**




# THEN LOOK AT THE UPPER PIPE *completely protected* BY INSUL-MASTIC

**The top pipe in this unretouched photograph has a three year old coating of INSUL-MASTIC, the *Superior* protective coating. The bottom pipe has been painted several times during those three years. These pipes are in a steel mill and both are constantly showered with acid vapors from a coke quenching tower which is around the corner of the building. So strong are the vapors that they sting the faces and arms of workmen, but three years of this punishment have not harmed the INSUL-MASTIC coated pipe.**

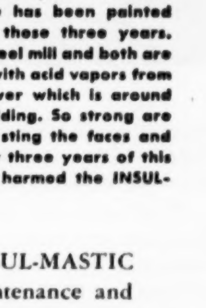
Steel mills throughout the country are learning that INSUL-MASTIC lasts for years and years and practically eliminates maintenance and replacement of metal equipment. These coatings are extremely resistant to acids, alkalis and moisture. They are specially made that way. The generous use of Gilsonite, one of nature's most chemically resistant minerals, helps give this lasting protection.

Save your tanks, structural steel, pipes, quench cars and everything on or near your coke batteries. Do as other mills are doing. Specify INSUL-MASTIC for coating this equipment.

*There is an INSUL-MASTIC representative near you. ★ ★ ★ Write for his name!*

*Think First of the Coatings that last!*

Insul-Mastic
CORPORATION OF AMERICA
Oliver Building • Pittsburgh 22, Pa.
*Representatives in Principal Cities*



# MECHANICAL ENGINEERING

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MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.


# *Light From Atomic Energy*

*(Light from one electric bulb dispels darkness with electricity generated by the Oak Ridge National Laboratory experimental homogeneous reactor. This unusual reactor successfully produced 150 kw of electric power—enough to serve 50 five-room houses. See "Atomic Power Production," MECHANICAL ENGINEERING, May, 1953, pp. 405–406.)*

Volume 75
No. 6

# MECHANICAL ENGINEERING

June
1953

GEORGE A. STETSON, *Editor*

## *For Tomorrow's Engineers*

TOMORROW'S engineers are today's schoolboys. They are to be found in every state of the Union. They are living in cities large and small, and in suburban and rural communities. They may be native Americans or foreign born. Their parents may be clerks, mechanics, farmers, professional people, or from any other walk of life. A few will be sons of engineers. Some live in industrial surroundings in the midst of evidences of the work of engineers, and have contacts with people who have a fairly clear idea of what an engineer does and what a career in engineering requires of, and has to offer to, a young man. Others know of these things only at second hand or not at all. Opportunities for choosing and planning a career under competent guidance will be abundant to some of these boys. Other boys will have to make their own opportunities and choose and plan for themselves. But regardless of all of these differences, all tomorrow's engineers have a common task before them. They must have what it takes to become an engineer and a desire to serve mankind, and they must acquire an education that will fit them to carry on a career in engineering.

To aid tomorrow's engineers—and their parents and advisers as well—in making a proper and intelligent choice of engineering as a career and to give them some general understanding of what engineering is, what engineers do, what they must know, how they are educated, how they progress in their profession, what major branches of engineering are open to them, and how to choose a college, the Engineers' Council for Professional Development has recently issued a 32-page pamphlet, "Engineering, a Creative Profession." This pamphlet is profusely illustrated with drawings which are suggestive of the material presented in the text. The style of the text is conversational and lively. High lights are presented with an economy of words and in language which the boy and the layman can comprehend. Although the reading time is brief, the text covers a lot of territory and should stimulate interest. A bibliography of supplementary readings—books, articles, reports—is provided for those who wish to pursue some phase of a very broad subject in greater detail.

The new ECPD pamphlet was prepared and edited by B. G. A. Skrotzki, chairman of the ECPD Guidance Committee, who has spent several years in the guidance-counseling activities of the engineering societies in the New York area. It has been designed to meet the situations which most commonly arise in interviews with young men who are considering engineering as a career and is based on long experience in this type of work. For this reason it should be particularly helpful to guidance counselors in the secondary schools and to parents and friends of boys, as well as the boys themselves.

That a shortage of engineers exists in this country, and probably will exist for some time, is well known. The industries that are based on engineering are in great need of young men to fill their ranks. Public advertisements for engineers are a common sight in metropolitan newspapers. The state of the nation and indeed of the world is such that it seems at present as though there would never be enough engineers to fill the needs. Such conditions are likely to attract young men into choosing engineering as a career. They also generate a need for guidance literature for two important but quite different reasons. One is to attract the right boys into engineering. The other is to convince boys that the requirements and standards of the engineering profession are so high that only those who have the talent and capacity to become engineers and are willing to work hard at college and on the job should consider engineering as a career.

From a number of points of view it is apparent that tomorrow's engineers must be men of the very highest quality of intellect and personality. The task before them will be more difficult than that which engineers have faced in the past. What engineers have done in the past has been a determining influence in changing the conditions under which men live together in the world and in improving the material standards of living which they enjoy. In the atmosphere of freedom and social evolution of the eighteenth and nineteenth centuries, in which the individual acquired a value and personal dignity previously enjoyed by only very few of the "little people" of the world, the engineer vastly multiplied man's productivity and mobility, and brought into contact and conflict men and ideas from all corners of the world. From the "freedom-loving Greeks" at Salamis and the English barons at Runnymede to the World Wars of the twentieth century and the "cold war" of today, the ideals of liberty and brotherhood have been sustained by one triumph after another of faith and courage. Opportunities and incentives for the realization of the satisfactions of human existence have grown as the engineer has eased the physical burdens of his fellow men and has improved their material well-being. But to retain and advance the benefits which the engineers of yesterday provided, tomorrow's engineers will have to play an even greater role.

As men are released from the long hours formerly necessary to provide for themselves the barest essentials of

existence, ever more complex machines and organizations are required. To devise, construct, and maintain in operation these machines and organizations, the engineer is essential. His field of service widens continuously as more of the elements of daily living and the happiness and livelihoods of the rest of the community become dependent on the engineer's technical ability and his capacity for greater service in administration. Men who have no technical knowledge, men of inferior intellectual powers, with indifference or ignorance of the needs and nature of humanity, with small-souled concepts of the obligations their profession thrusts upon them, with false or stunted ideals of "service to mankind," cannot maintain the work of the world. They cannot meet the competition which other nations, including those living under different and humanly degrading philosophies of government, are setting for them. Tomorrow's engineers must be the best men the nation has to offer, and hence it is vitally important that boys who are today in our preparatory schools know what is required of them and how richly they can serve their fellow men if they choose engineering as a career.

## *Citizenship Manual*

THE Engineers Civic Responsibility Committee of The American Society of Mechanical Engineers was organized in 1933, as a result of strong convictions and infectious enthusiasm growing out of personal experience in public service, by the late Roy V. Wright, who served the Society as its president in 1931 and was elected an honorary member in 1943.

Dr. Wright was not the first ASME president to set a premium on the responsibilities of citizenship nor the first to encourage his fellow engineers, by precept and example, to take an active part in community and public affairs. Many ASME presidential addresses, beginning with those delivered by the first president, Robert Henry Thurston, bear on this general theme in whole or in part. Indeed, the By-Laws of the Society include among the stated objectives, such specific ones as "encouraging a high standard of citizenship among engineers; encouraging engineers to participate in public affairs; and co-operating with governmental agencies in engineering affairs." And the roster of members of the Society from 1880 to date is rich in the names of engineers who have served their fellow men not only professionally as inventors, industrialists, administrators, teachers, government employees and public servants, but also voluntarily with a deep sense of selfless devotion in a wide variety of humanitarian, cultural, religious, educational, and political causes in community, state, and national affairs. But it was the Engineers Civic Responsibility Committee formed by Dr. Wright which represented the first organized attempt on the part of the Society to offer continuous leadership, encouragement, and instruction to individuals and Society Sections in setting up practical programs of good citizenship.

In recognition of the services of Dr. Wright to the cause of good citizenship the ASME established the Roy V. Wright Memorial Lectures which are delivered at every national meeting. The lecturers, men of national prominence, have been chosen by the Committee and serve to keep constantly before members of the Society the ideals of public service held by Dr. Wright.

The success of a democracy depends on the active practice of good citizenship by every member of the nation. In this respect the engineer has the same obligations as every other citizen. But because of his specialized knowledge and work, the engineer has an additional obligation and abundant opportunities to serve his community and the nation not only as an individual but also through his professional society. Hence, in addition to sponsoring the Roy V. Wright Memorial Lectures, the ASME Engineers Civic Responsibility Committee attempts to aid ASME members and Sections in meeting those specialized obligations of citizenship and public service which devolve on engineers. To this end the Committee has prepared ASME Manual MS-61, "Citizenship and Participation in Public Affairs," with supplementary notes and reprints of some of the Roy V. Wright Memorial Lectures.

The ASME Manual was prepared as "a blueprint for action." In the words of the Manual, "it aims to stimulate a growth of interest in ever-present civic obligations and an eternal alertness to opportunities for services which arise suddenly and pass quickly." It is reasonably brief, but practical. It shows how the Section can aid the individual member, how the Section can serve the community, with specific suggestions for getting into action, and how the Section can serve the nation. In order to present a case history showing how one community has been served by its engineering society, there has been incorporated in the Manual a description of the organization, methods of operation, and some achievements of the Civic Affairs Committee of the Engineering Society of Detroit, Inc. No engineer can read about what has been done in Detroit without having his imagination fired to the point of visualizing what the engineers of his own community might accomplish under a similar program.

In the Roy V. Wright Lecture, delivered at the 1951 ASME Spring Meeting and reprinted in the ASME Manual, Frank H. Neely said, "What 'should be done' appalls us; the engineer perceives it. He must train himself in the school of life to accept the challenge. He must prepare to take his place among his citizens, he must assume leadership, he must work fearlessly and imaginatively for and with his fellow citizens, he must represent not only himself in the community of nations, but the highest ideals and talents of the engineering profession. The citizenship that Roy Wright practiced stands as a noble example to all engineers . . . . ."

With determination to expand the practice of good citizenship from the normal obligations of the individual to the broader field of the specialized services which engineers working together can perform because of their knowledge and competence, ASME Sections throughout the nation should be able to convince their fellow citizens that engineering is "service to mankind."

# *Statistical Aspects of Specifications*

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THE "NORMAL" CURVE

It is a well-recognized fact that if we measure a group of similar objects, as found in nature, and then plot these measurements according to the frequency of their occurrence, we obtain a bell-shaped type of curve or distribution. Because this curve was found to be so common in nature, it came to be called the normal curve. For example, if we measure the individual heights of a group of men and plot these measurements according to the frequency of their occurrence, we may expect to find a normal curve as shown in Fig. 1. More measurements will be concentrated at the average value than at any other point along the axis and the farther away we get from this average value, the fewer the number of measurements that will be found for each value. Furthermore, the measurements will be distributed symmetrically about the average line.

The statistician will go on to demonstrate that when the area under the curve is divided into six strips or zones of equal width, 68 per cent of the observed values will lie within the middle third, $95^1/_2$ per cent will lie within the middle two thirds, and 99.7 per cent of all the values will be found within the area under the curve, and only 0.3 per cent will lie under the extreme tails of the curve, Fig. 2. He further uses the Greek letter "sigma" ($\sigma$) to name or define the width of the strips, and by "3-sigma limits," he means the area included within the three zones to the left of the average plus the similar area to the right of the average value. The 3-sigma limits are often referred to as the "danger limits" of the process.

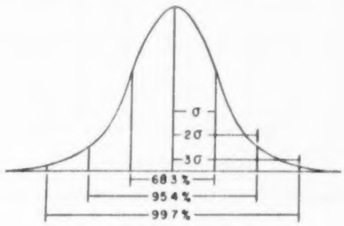


FIG. 2 NORMAL CURVE

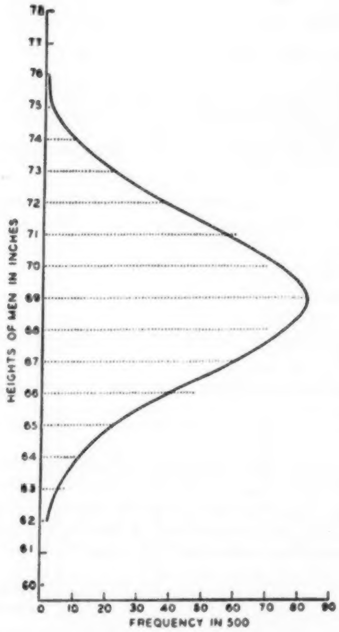


FIG. 1 NORMAL CURVE FOR HEIGHTS FOR MEN

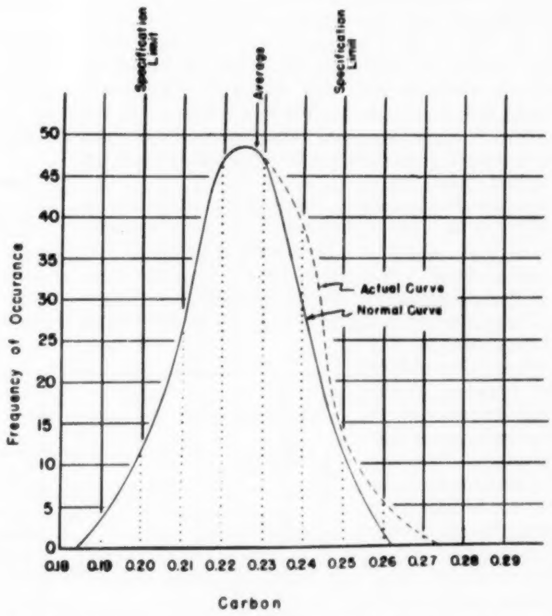


FIG. 3 FREQUENCY-DISTRIBUTION CURVE FOR CARBON VALUES

APPLYING THE NORMAL CURVE TO PRODUCTION

This same normal chart can be drawn to record the measurements of a process or of a product. As long as the process or product is behaving "normally," the curve may not be so exactly symmetrical as that indicated, but it will approximate the distribution. Thus we may chart 200 consecutive carbon determinations for a certain grade of steel in the form of a normal curve, with the result shown in Fig. 3. The solid line represents the ideal curve while the dash-line curve includes the observations. The curves, it is seen, do not coincide exactly, but approximate each other.

Now, if we are trying to stay within the range of 0.20 to

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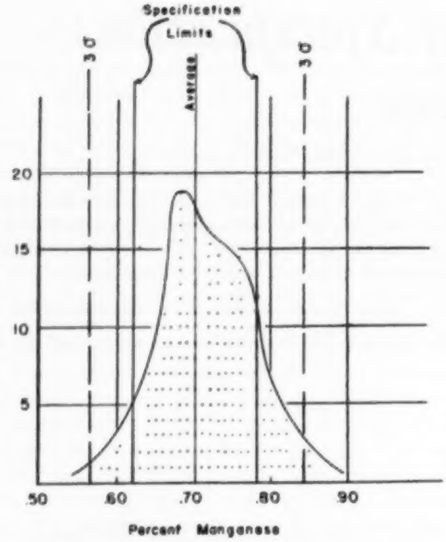


FIG. 4 FREQUENCY-DISTRIBUTION CURVE FOR MANGANESE

0.25 per cent carbon, we can indicate these specification limits on the chart and readily estimate the degree of carbon control. Thus, in the present case, the specification limits have been set so that they fall inside the 3-sigma limits of the normal curve. This indicates at once that the process is operating under conditions which permit a wider spread of carbon values than were set, and we can see readily how much wider the spread is. If such conditions cause variations in the product that are objectionable, steps should then be taken in the melting process to correct them.

If we consider 200 successive manganese determinations (corresponding to the carbon determinations just discussed), we can chart them and obtain a curve such as shown in Fig. 4. It is readily apparent that we do not have a normal distribution of manganese values, for the distribution is unsymmetrical. There is one peak at 0.68 per cent manganese and an attempt to peak at about 0.75 per cent. Now, if we add the specification limits to the picture it is also obvious that the spread of results is greater than the desired range. If we then add the 3-sigma limits to the picture we see what the limits of the process are as it is operating at present.

According to theory, an occasional measurement, 1 in 100 perhaps, can be expected to fall outside these limits and yet have a process that is operating satisfactorily. Thus we see that this manganese control is within the expected variations of the process, as it is now operating, but it does not meet the specification requirements imposed on it, nor is it an exactly normal process.

All too often process limits or specifications are set up without any particular reference to the process possibilities and, just as frequently, the manufacturer does not stop to analyze the process capability to know whether he can meet certain requirements or what steps he must take to meet them.

### APPLYING STATISTICAL TECHNIQUES

A simple solution to such problems is the use of the statistical techniques just described. These may often furnish an adequate basis for setting tolerances or for evaluating process capability. In Fig. 5 are schematically presented three possible conditions. Condition A represents such a one as is shown in the previous example for carbon and manganese control, where the specification or tolerance limit is inside the 3-sigma limits of the process, resulting in the production of some unsatisfactory material. Condition B shows where the tolerance limits coincide with the control limits of the process as it is operating. This represents a satisfactory condition as long as the process operates as well as it does now, but there is no flexibility. The third condition (shown in C) is the one that is most acceptable, provided the tolerance limits are not too wide for an acceptable product. An accepted figure is for the width of the tolerance limits to be 1.33 times the 3-sigma limits.

For process-control and process-evaluation charts, the $\bar{X}$ and $R$ type of chart is the type that is more commonly used than the normal curve or frequency-distribution curve. One reason for this is that the $\bar{X}$ and $R$ chart is a more continuous representation of the process than the frequency chart. Also, process trends can be noted and corrective action taken when the $\bar{X}$ and $R$ charting is used.

As an example, the carbon values considered and charted in the frequency-distribution chart, Fig. 3, have been recharted as shown in the $\bar{X}$ and $R$ chart, Fig. 6. Here the carbon values

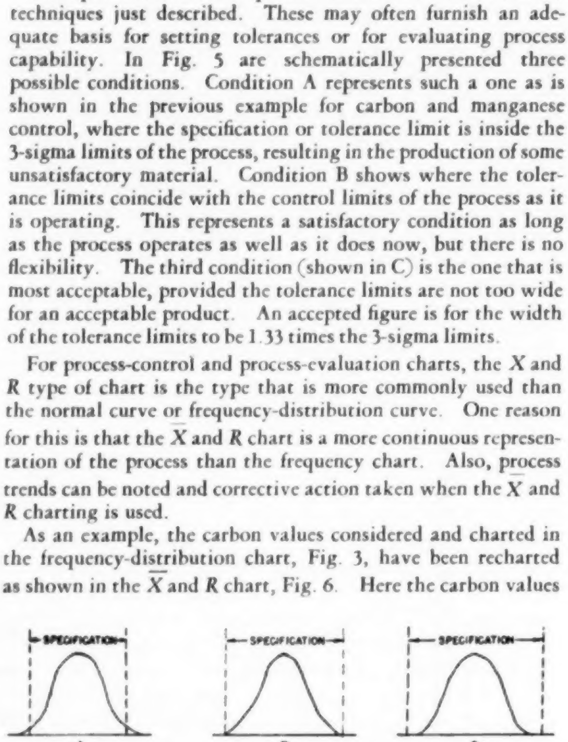


FIG. 5 NORMAL CURVES AND SPECIFICATIONS FOR THREE PROCESSES

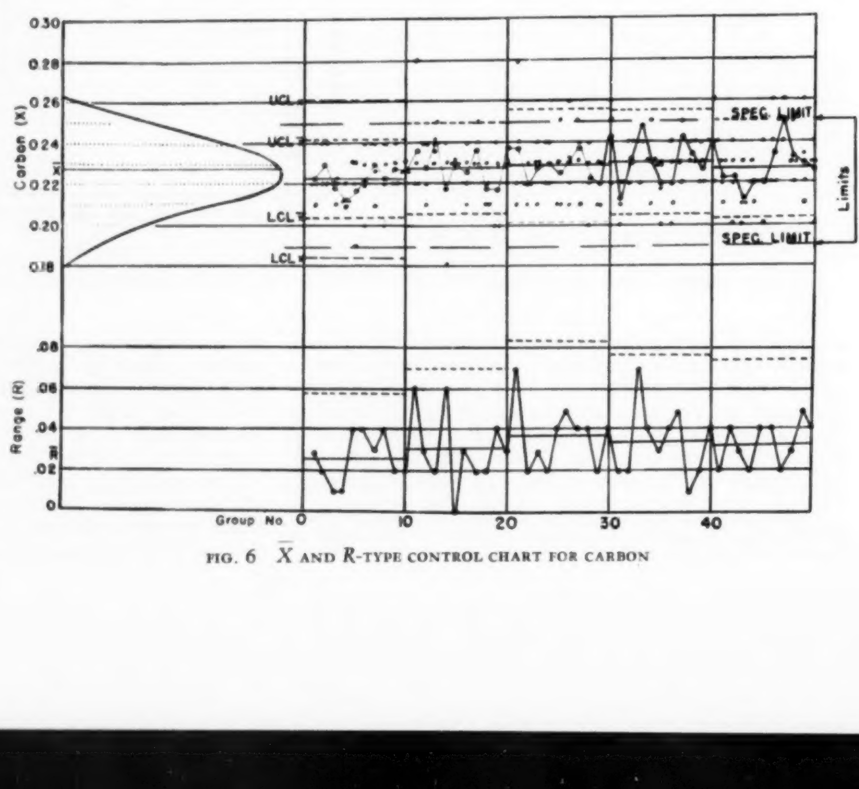


FIG. 6 $\bar{X}$ AND $R$-TYPE CONTROL CHART FOR CARBON

are grouped by lots of four consecutive values (designated as groups) so that a continuous sort of record is obtained as shown on the chart. It will be noted that the values are grouped as four individual determinations (shown as dots) and also that lots of 10 groups (40 determinations) also are considered together. The average value for each grouping of four values is shown as a circle and the spread between greatest and smallest values in each lot is shown at the bottom of the chart as the range value for each group. Average values for each lot of ten consecutive groups are also calculated both for the carbon values and for the range values, as shown on the chart.


FIG. 7 $\bar{X}$ AND $R$-TYPE CONTROL CHART FOR TENSILE STRENGTH

From these data, control limits are calculated according to the formulas given in any textbook on the subject and these limits also are drawn on the graph. Thus two sets of control limits can be calculated—those for the averaged values and those for the individual values. Hence we have noted on the chart the upper control limit (UCL) and the lower control limit (LCL) for the average values ($\bar{X}$-values) and for the individual values ($X$-values). The control limits for the individual values correspond almost exactly with the 3-sigma limits of the normal curve. This is as it should be since both are measuring the same thing.

The specification limits that have been set up for the process also can be included, thereby giving a fairly complete picture. The control-chart limits themselves are determined by the process involved and reflect with mathematical certainty what the process is capable of making. It also must be remembered that specifications normally relate to individual test values while frequently the control-chart limits are calculated for the average values only. Hence control-chart limits for averages theoretically should not be related directly to the specification limits.

In evaluating mechanical properties, such as tension tests where only a minimum is specified, it is common industrial practice to work to such a quality level that while the lower control limit for averages falls above this specified minimum, the lower control limit for individuals falls below the minimum. Rarely, however, will it fall more than $1^1/_2$ sigmas below and, when it reaches this point, about 7 per cent of the items in a normal distribution will be expected to fall below the specification minimum but not below the lower control limit for individuals. The reason, of course, is that in most cases retests are permitted because testing equipment sometimes is not as precise as we would like to have it, and more particularly because the test bars may contain flaws that are not characteristic of the product involved. Assuming that 7 per cent of the product, as produced, will fail on the first test, the probability of the retest failing is only 7 per cent so that if one retest is permitted the expectancy is that only about $^1/_2$ per cent of the product will be rejected. Therefore it is normally not economical for the producer to work to a higher quality level since occasional retests are often less costly than raising the general quality level of the product.

### CONTROL LIMITS

Where both a maximum and minimum are specified, it is generally desirable that the control limits for individuals come somewhat closer together than the specification limits. To be considered a satisfactory situation, the width of the control band for individuals should not exceed $^3/_4$ of the width of the specification band.

An example of the type of chart used for the mechanical properties just mentioned is shown in Fig. 7. This represents the ultimate strength level of steel made to meet AAR grade "B" specifications. The specified minimum strength of 70,000 psi is shown as are the control limits for each group of 40 values.

It will be noted that we were operating at a strength level and with a small enough range or spread of results so that the lower control limit for averages ($LCL_{\bar{X}}$) was well above the specification minimum, while the lower control limit for individuals ($LCL_X$) was fluctuating about the minimum which indicates a very desirable condition. This indicates that the process is operating at a level and with enough uniformity of results that we need expect only slightly more than three failures in 1000 tests (the 99.7 per cent value under the normal curve which was discussed previously). Moreover, it indicates that the level was maintained over this period of operation both for average strength and for range or scatter of results. Should the level drop or the scatter increase so that the lower control level drops materially, an investigation into process operation is in order.

An example of the dimensional type of chart, where both a maximum and a minimum are specified, is shown in Fig. 8. These measurements are of the specified distance between the journal-box wedge lugs in a certain type of side frame for freight-car application. Sample lots of five castings were selected twice daily and the distances at the top and bottom of the lugs measured. It soon was apparent that the bottom of the lugs was wider than the upper tolerance limit would permit and this was confirmed by the extra finishing required at this point.

A pattern change was made which was based on the control-chart information and measurements were resumed. The effects of this corrective step were sufficient to bring the control limits for both dimensions well within the specification limits

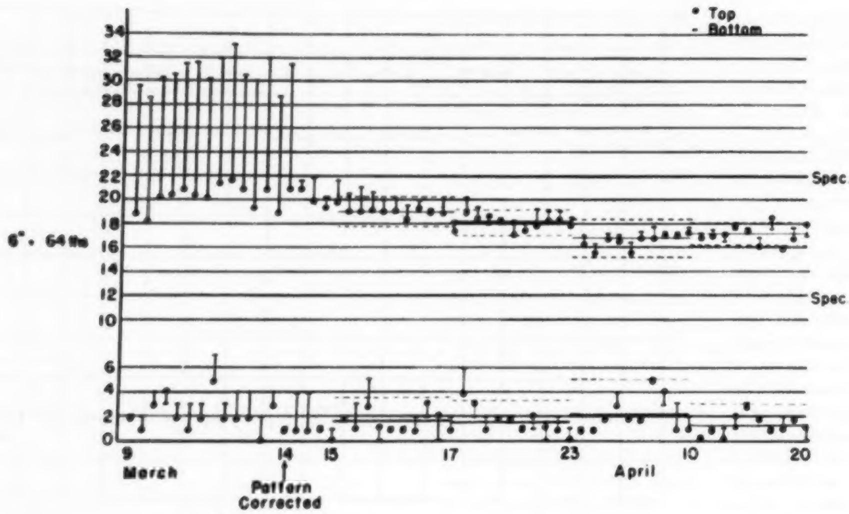


FIG. 8 $\overline{X}$ AND $R$-TYPE CONTROL CHART FOR DIMENSIONAL CONTROL

as desired, and the control chart maintains an accurate check on this dimensional control.

Similar control-chart applications can be made to any dimensional control of forgings or castings to afford a factual picture both of the process performance and its capability, as well as to provide information as to the justification for the specification tolerances that may have been set up for the process under consideration.

# Tolerances and Specifications for Aluminum and Magnesium Castings


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## FOUNDRY PROBLEMS

A FUNDAMENTAL problem important to the foundry in the production of a cast shape is the establishment of a sequence of solidification so that the change in unit volume on solidification can be compensated for satisfactorily. Wherever possible, the designer should use sections which are tapered so that they increase in thickness toward points accessible to feed metal. If tapered sections are not practicable, a uniform section thickness should be maintained. If it is necessary to use a design where light and heavy sections join, a gradual increase in thickness from the light to the heavy section is most desirable. This serves to minimize abrupt changes in solidification rate and promotes a condition more satisfactory for progressive solidification.

The low specific gravity of aluminum and magnesium alloys and the problems involved in pouring these alloys at high temperatures impose a lower limit on the thickness of section which can be cast successfully. The limitation with respect to minimum section thickness and changes in section thicknesses apply also to the design of ribs, bosses, and fillets in aluminum and magnesium alloy castings. In general, no radius on a cast surface should be less than the thickness of the thinner of the two joining sections. If the thickness of the larger of two sections exceeds the smaller by 50 per cent, a gradual blending of the lighter section to the heavier should be used in addition to the fillets.

Fig. 1 illustrates examples of the recommended practice for section juncture, bosses, ribs, and machining details for aluminum and magnesium alloy castings.

It is often desirable to cast inserts of other metals in aluminum and magnesium castings in order to form wear-resisting surfaces. Cast iron and steel are the most suitable materials, although copper and brass are sometimes used. Inserts usually are retained mechanically in the casting by knurling, grooving, or projections on the insert. Iron and steel inserts also can be bonded metallurgically to aluminum castings; for example, cast-iron ring carriers are bonded metallurgically to permanent-mold cast pistons for heavy-duty diesel engines.

The support of cores in castings sometimes requires core prints through a casting wall which may be objectionable from a design standpoint. In such cases, cores can be supported by chaplets, but this method is not advisable if the casting is re-

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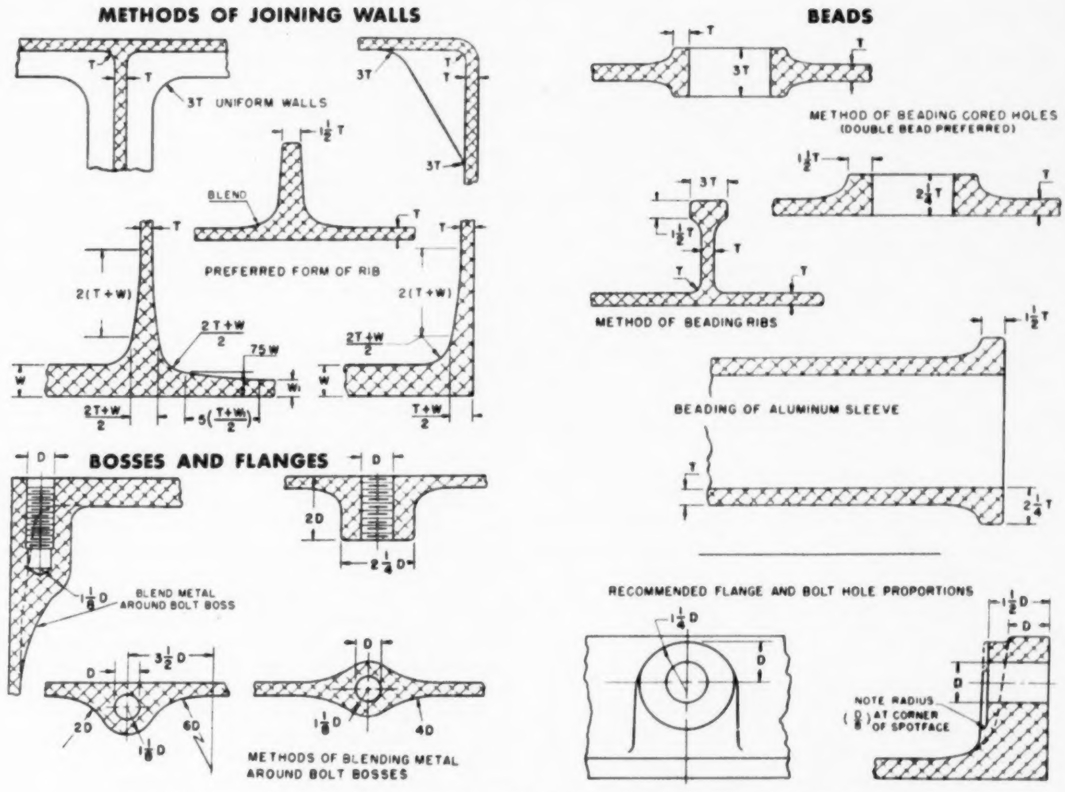



FIG. 1 SOME SUGGESTED DESIGN DETAILS FOR ALUMINUM AND MAGNESIUM ALLOY CASTINGS

quired to be pressure-tight. A better method in this case is to provide core-support holes of adequate size, which can be sealed with welded, threaded, or cupped plugs. Adequate beading to support such plugs should be provided.

The mechanical properties of aluminum and magnesium casting alloys for specification purposes are normally based on tests of individually cast specimens having a test section $^1/_2$ in. diam. This test-bar casting has been designed to provide optimum reproductibility of results and to reflect such changes in composition, metal-handling practices, or heat-treatment as may have occurred in its production. However, the properties of separately cast test bars do not necessarily represent the properties which would be provided by castings. These casting properties may be higher or lower depending on a number of factors which influence the solidification rate of the metal in the mold or the soundness of the casting section. For example, test specimens machined from a heavy section of a casting may provide lower properties than separately cast specimens because the rate of solidification is relatively slow. Conversely, the high solidification rate of a thin section may result in higher mechanical properties than those shown by separately cast specimens.

This condition is not peculiar to aluminum and magnesium alloys, but is true to various degrees of all cast metals. Because of this factor, the properties of test specimens machined from a single casting also will vary depending upon the location in the casting. Many purchasing and engineering specifications recognize this factor and require that the average tensile strength and elongation of specimens machined from the heaviest, intermediate, and lightest section of the casting be not less than 75 per cent and 25 per cent, respectively, of the values required for separately cast specimens. There is no general rule by which this relationship can be determined in a particular design, and the designer, through experience, must develop the proper factor of safety to apply to the mechanical properties specified for an alloy in determining the design stress to be applied.

### ALUMINUM AND MAGNESIUM ALLOY SAND CASTINGS

The sand-casting process is the most versatile method of producing a cast shape and, in fact, is characterized by its universal adaptability. This process is employed for the production of (*a*) small quantities of identical castings, (*b*) parts requiring intricate coring, (*c*) large castings, and (*d*) castings of a design suitable to modern high-speed mold equipment and methods where production costs lower than those of other fabricating methods can be established.

The type of pattern equipment selected will depend largely upon the dimensional accuracy required and the total quantity of castings required or the production rate which is desired for control of unit cost. Production rates are controlled by the type of pattern equipment as well as by the molding equipment and may range from a few parts per hour for medium-sized castings using loose pattern equipment to several hundred parts per hour for small castings using metal match plate equipment. Pattern equipment will incorporate the required shrinkage allowance and the necessary stock for finishing. Shrinkage allowance for both aluminum and magnesium alloy sand castings may be as much as $^5/_{32}$ in. per ft, but variations in casting design, alloy, and resistance to contraction offered by the mold may make necessary an allowance as small as $^1/_{10}$ in. per ft.

The actual shrinkage allowance for a particular casting design, therefore, must be determined by experience, and consultation with the foundries on this detail will often prove helpful.

Molding in sand is not a precision operation because of variations inherent in the process. These variations are introduced, among other factors, by ramming of the sand onto the pattern, drawing the pattern, and setting of cores. Variations in the dimensions of the resulting casting are introduced by trimming and heat-treating. These variations are, of course, controllable by such practices as the use of gages for setting cores and the use of special racks or fixtures during heat-treatment when the production quantities are such as to justify this equipment.

The over-all effect of these fabrication tolerances is reflected in the dimensional tolerances that can be maintained in the sand-casting process. The standard tolerance for both aluminum and magnesium sand castings is $\pm\,^1/_{32}$ in. This tolerance will apply to such dimensions as length, flatness, and wall thickness in most castings made from mounted pattern equipment having a maximum dimension of 12 in. Beyond this point it is inaccurate to generalize about sand-casting tolerances because of the effect of casting size. As an example of the effect of size on the tolerance for length dimensions, the following can be considered examples of acceptable tolerances:

| Length dimension, in. | Tolerance, in. |
|---|---|
| Up to 12 | $\pm\,^1/_{32}$ |
| 12 to 24 | $\pm\,^3/_{64}$ |
| 24 to 36 | $\pm\,^1/_{16}$ |
| 36 to 60 | $\pm\,^3/_{32}$ |
| Over 60 | $\pm\,^1/_8$ |

Wall-thickness tolerances are also a function of casting size, and the size and weight of cores which must be set and supported in the mold. For example, in large sand castings, weighing 400 to 1000 lb in an aluminum alloy, a wall-thickness tolerance of $\pm\,^3/_{32}$ in. sometimes may be necessary.

All the tolerances mentioned thus far are for castings made in green-sand molds with or without dry-sand cores. When the entire mold is made in dry sand, closer tolerances can be held provided the casting is not too large.

Closer dimensional tolerances than those obtainable by the sand-casting process normally are obtained by machining, and finish allowance for such machining is necessary. The normal practice is to provide $^1/_8$ in. for such finish on small and medium-sized castings in both aluminum and magnesium alloys. Large castings usually require $^1/_4$ in. or more finish allowance, particularly on those surfaces cast in the cope of the mold. Whenever possible, the engineer should design the casting so that the surfaces which are to be machined can be cast in the drag of the mold.

Although a relatively smooth surface can be obtained on aluminum-alloy castings with fine sand, the use of such sand is limited to rather small castings. Larger castings require somewhat coarser sand in order to provide the increased mold permeability necessary for better casting soundness. This latter factor is most important in the production of sound magnesium-alloy castings, and, in general, aluminum sand castings have somewhat better surface smoothness than magnesium sand castings. Special requirements for surface smoothness on sand castings exert a marked influence on their cost, and the designer should consider carefully the necessity for specifying excessively smooth as-cast surfaces.

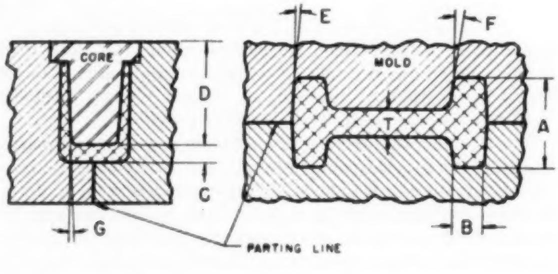
#### ALUMINUM AND MAGNESIUM ALLOY PERMANENT-MOLD CASTINGS

In the permanent-mold process, metal molds and cores are used and the metal is poured into the mold cavity under a normal gravity head. The semipermanent-mold process is a variation of this process and offers somewhat more versatility through the use of dry-sand cores, thus overcoming many of the design limitations imposed by metal cores. Permanent-mold castings are characterized by their metallurgical superiority, closer dimensional tolerances, superior surface finish, pressure-tightness, and for certain sizes or designs, greater speed of production and lower cost per piece than sand castings.

The metallurgical superiority of this process is more pronounced in the case of aluminum castings than with magnesium castings. This superiority results from the chilling imposed by the metal mold and the consequent refinement of the structure and reduction in porosity in the castings. This results in a substantial improvement in the strength over similar parts cast in sand. In most cases, magnesium alloys will show somewhat higher mechanical properties when they are cast in permanent molds.

Mold equipment for permanent molds is usually constructed from a good grade of dense cast iron, the cavities being machined to the desired contour. Metal cores when required usually are machined from alloy steel. Sand cores for semipermanent-mold castings are of the same general type as those used for sand castings and require the same production equipment.

As with sand castings, it is difficult to define the minimum section thickness that can be produced by the permanent-mold process because of the effect of casting size upon this factor. A section thickness of $^1/_8$ in. over an area of 3 in. or less is usually considered to be the minimum acceptable to the foundry. For larger areas, the minimum section thickness should be $^5/_{32}$ in., and a minimum section of $^3/_{16}$ in. is usually required if the shortest dimension of the web area exceeds 6 in. The minimum diameter for cored holes is dependent upon a number of factors including depth of the hole and location of the hole with respect to various parts of the mold. In general, best design practices would be to provide for no cored holes less than $^3/_8$ in. diam. Smaller holes usually can be produced more economi-




(A) ACROSS PARTING LINE
$\pm\frac{1}{64}$ FOR ONE INCH OR LESS — ABOVE ONE INCH ADD .002 TO TOLERANCE PER INCH OF LENGTH.

(B) BETWEEN POINTS PRODUCED BY ONE PART OF THE MOLD
$\pm\frac{1}{64}$ FOR ONE INCH OR LESS — ABOVE ONE INCH ADD .001 TO TOLERANCE PER INCH OF LENGTH.

(C) BETWEEN POINTS PRODUCED BY THE CORE AND MOLD
$\pm\frac{1}{64}$ FOR ONE INCH OR LESS — ABOVE ONE INCH ADD .002 TO TOLERANCE PER INCH OF LENGTH.

(D) MAXIMUM LENGTH OF CORE SUPPORTED AT ONE END
DIAMETER OF CORE X 10.

(E) OUTSIDE DRAFT
1° MINIMUM — 3° DESIRABLE

(F) DRAFT IN RECESSES
2° MINIMUM — 5° DESIRABLE

(G) DRAFT ON CORES
$\frac{1}{2}$° LIMITED — 2° DESIRABLE

NOTE:
(1) MINIMUM DIA OF CORES — $\frac{1}{4}$

FIG. 2 PERMANENT-MOLD TOLERANCES

cally during machining of the casting. Dimensional tolerances depend upon the size and complexity of the casting and the location of the dimensions involved with respect to the moving parts of the mold. Typical minimum tolerances are given in Fig. 2 along with a sketch of the significant mold-design features which influence these tolerances.

As in the case of sand castings, it is possible to maintain closer than normal tolerances on certain specific dimensions. Examples are permanent-mold pistons, where diameters across chucking points are held to ±0.010 in. and head thicknesses are held to ±0.010 in. In the case of one flatiron soleplate casting, the height of seven cover-locating lugs is held to within ±0.003 in. of the same plane.

Machine allowances for permanent-mold castings can be somewhat less than those indicated for sand castings. For castings up to 10 in. long, a minimum machining allowance of $^1/_{32}$ in. should be provided, with $^3/_{64}$ in. desirable. For castings over 10 in. long, the minimum machining allowance is $^3/_{64}$ in. with $^1/_{16}$ in. desirable. In semipermanent-mold castings on surfaces formed by sand cores, $^1/_{16}$ in. minimum machining allowance should be provided.

The surface finish of permanent-mold castings is governed by the smoothness of the mold surfaces and the proper control of mold coatings, the use of such coatings being essential to this process. The finish is superior to that provided by sand castings. Surfaces produced by sand cores in semipermanent-mold castings are, of course, dependent upon the smoothness of the core.

### LAYOUT AND TARGETING OF CASTINGS

Locating points to be used by the machine shop should be marked clearly on the casting drawing so that both machine shop and foundry will check the castings from the same point. Layout fixtures are commonly used by the foundry in inspecting the dimensions of castings. These fixtures usually are related to locating points on the as-cast surface of the part.

By arrangement with the foundry, a casting purchaser can arrange to have targeting points placed on the casting. These points usually are produced by spotfacing to a desired depth, drilling holes, or combinations of these operations. The points so located by the foundry serve as the locating points for later machining operations by the customer.

A typical targeting operation is shown in Fig. 3. Critical casting dimensions are located by various fixed and hinged portions of the fixture, as a check for over-all dimensional accuracy, and the location of targeting points is established by guides for drilling or spot-facing. The cost of targeting fixtures usually limits their use to high-production castings subject to intricate machining operations.

### SPECIFICATIONS—ALUMINUM AND MAGNESIUM ALLOY SAND AND PERMANENT-MOLD CASTINGS

Aluminum and magnesium alloys suitable for casting by the sand or permanent-mold process are available in a wide range of physical and mechanical properties. Depending upon the application, such factors as mechanical properties at room temperature or elevated temperatures, resistance to corrosion, electrical conductivity, coefficient of thermal expansion, and thermal conductivity may be the ruling factor in the choice of alloy. It is beyond the scope of this paper to present a detailed summary of all of these characteristics.

Recognizing the need for a compilation of this nature, the Aluminum and Magnesium Division of the American Foundrymen's Society has embarked upon a program to assemble and present the properties and characteristics of aluminum and magnesium casting alloys in condensed tabular form. This program has been completed for the aluminum alloys and certain preliminary data are available.[1] Additional data are summarized in Tables 1 to 4.

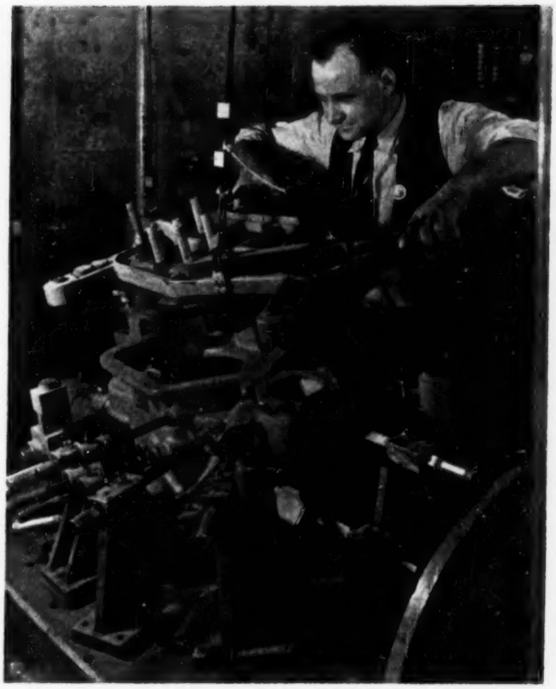


FIG. 3 TARGETING FIXTURE FOR A MAGNESIUM ALLOY SAND CASTING

Since the summary proposed for magnesium-alloy castings has not yet been completed and published, some additional detail for these alloys is warranted.

Of the magnesium alloys available in the form of sand castings and permanent-mold castings, there is only a slight variation in physical properties such as density, coefficient of expansion, thermal conductivity, and electrical conductivity. For instance, the weight per cubic inch of all alloys commonly used is 0.066 lb, and the coefficient of expansion for all alloys is $14.5 \times 10^{-6}$ in/in per deg F in the range 65 F to 212 F, and $16.0 \times 10^{-6}$ in/in per deg F in the range 65 F to 750 F. The range in thermal conductivity available is only 0.17-0.18 cgs units and the range in electrical conductivity expressed in per cent of the International Annealed Copper Standard is 9.9 to 15.0 per cent. Higher electrical conductivity is available in magnesium alloys but not in those commonly used for sand and permanent-mold castings.

Variations in mechanical properties of magnesium alloys commonly used for sand and permanent-mold castings are to some extent dependent on chemical composition, but the most profound effect results from thermal treatments of various types. At this point it becomes necessary to distinguish between alloys that can be cast successfully in permanent molds and those which can be cast in sand. In general, only the alloys with superior casting characteristics are cast in permanent molds. These are the ASTM designations AZ92A and AM-100A. The alloys commonly used for sand castings are the ASTM designations AZ92A, AZ63A, and AZ91C. It should be mentioned that AZ63A has less desirable foundry character-

[1] "Aluminum Alloy Characteristics," Alloy Recommendations Committee, Aluminum and Magnesium Division, *American Foundryman*, vol. 20, November, 1951, pp. 57–59.

TABLE 1 MECHANICAL PROPERTIES OF SAND-CAST ALUMINUM ALLOYS

| Alloy designation ASTM B26-52T | Alloy designation Commercial | Condition or temper | Minimum properties: Yield strength, psi | Minimum properties: Tensile strength, psi | Minimum properties: Elongation, % in 2 in. | Typical properties: Yield strength, psi | Typical properties: Tensile strength, psi | Typical properties: Elongation, % in 2 in. | Typical properties: Brinell hardness, 500 Kg-10 mm | Typical properties: Shearing strength, psi | Typical properties: Endurance limit, psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C4A | 195 | -T4 | ... | 29000 | 6.0 | 16000 | 32000 | 8.5 | 60 | 26000 | 7000 |
| | | -T6 | ... | 32000 | 3.0 | 24000 | 36000 | 5.0 | 75 | 30000 | 7500 |
| | | -T62 | ... | 36000 | Not required | 34000 | 40000 | 1.5 | 95 | 32000 | 8000 |
| | | -T7 | ... | 29000 | 3.0 | 19000 | 33000 | 4.0 | 70 | 24000 | ... |
| CG100A | 122 | -T2 | ... | 23000 | Not required | 20000 | 27000 | 1.0 | 80 | 21000 | 9500 |
| | | -T61 | ... | 30000 | Not required | 40000 | 41000 | 0.5 | 115 | 32000 | 8500 |
| CN42A | 142 | -T21 | ... | 23000 | Not required | 18000 | 27000 | 1.0 | 70 | 21000 | 6500 |
| | | -T61 | ... | 32000 | Not required | 32000 | 37000 | 0.2 | 105 | 32000 | 8000 |
| CS43A | 108 | -F | ... | 19000 | 1.5 | 14000 | 21000 | 2.5 | 55 | 17000 | 11000 |
| CS72A | 113 | -F | ... | 19000 | Not required | 15000 | 24000 | 1.5 | 70 | 20000 | 9000 |
| G4A | 214 | -F | ... | 22000 | 6.0 | 12000 | 25000 | 9.0 | 50 | 20000 | 7000 |
| G10A | 220 | -T4 | ... | 42000 | 12.0 | 25000 | 46000 | 14.0 | 75 | 33000 | 8000 |
| GS42A | B214 | -F | ... | 17000 | Not required | 13000 | 20000 | 2.0 | 50 | 17000 | ... |
| S5A | 43 | -F | ... | 17000 | 3.0 | 8000 | 19000 | 8.0 | 40 | 14000 | 8000 |
| SC51A | 355 | -T6 | ... | 32000 | 2.0 | 25000 | 35000 | 3.0 | 80 | 28000 | 9000 |
| | | -T51 | ... | 25000 | Not required | 23000 | 28000 | 1.5 | 65 | 22000 | 7000 |
| | | -T71 | ... | 30000 | Not required | 29000 | 35000 | 1.5 | 75 | 26000 | 10000 |
| SC64C | 319 | -F | ... | 23000 | Not required | 18000 | 27000 | 2.0 | 70 | 22000 | 10000 |
| | | -T6 | ... | 31000 | 1.5 | 24000 | 36000 | 2.0 | 80 | 29000 | 10000 |
| ZG61B | A612 | -F | 20000 | 32000 | 2.0 | 25000 | 35000 | 5.0 | 75 | ... | 8000 |
| SG70A | 356 | -T6 | ... | 30000 | 3.0 | 24000 | 33000 | 3.5 | 70 | 26000 | 8500 |
| | | -T51 | ... | 23000 | Not required | 20000 | 25000 | 2.0 | 60 | 20000 | 7500 |

TABLE 2 MECHANICAL PROPERTIES OF PERMANENT MOLD CAST ALUMINUM ALLOY

| Alloy designation ASTM B108-52T | Alloy designation Commercial | Condition or temper | Minimum properties: Yield strength, psi | Minimum properties: Tensile strength, psi | Minimum properties: Elongation, % in 2 in. | Typical properties: Yield strength, psi | Typical properties: Tensile strength, psi | Typical properties: Elongation, % in 2 in. | Typical properties: Brinell hardness, 500 Kg-10 mm | Typical properties: Shearing strength, psi | Typical properties: Endurance limit, psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CG100A | 122 | -T551 | ... | 30000 | Not required | 35000 | 37000 | 0.5 | 115 | 30000 | 8500 |
| | | -T65 | ... | 40000 | Not required | 36000 | 48000 | 0.5 | 140 | 36000 | 9000 |
| CN42A | 142 | -T571 | ... | 34000 | Not required | 34000 | 40000 | 1.0 | 105 | 30000 | 10500 |
| | | -T61 | ... | 40000 | Not required | 42000 | 47000 | 0.5 | 110 | 35000 | 9500 |
| CS42A | B195 | -T4 | ... | 33000 | 4.5 | 19000 | 37000 | 9.0 | 75 | 30000 | 9500 |
| | | -T6 | ... | 35000 | 2.0 | 26000 | 40000 | 5.0 | 90 | 32000 | 10000 |
| | | -T7 | ... | 33000 | 3.0 | 20000 | 39000 | 4.5 | 80 | 30000 | 9000 |
| CS72A | 113 | -F | ... | 23000 | Not required | 19000 | 28000 | 2.0 | 70 | 22000 | ... |
| CS104A | 138 | -F | ... | 26000 | Not required | 24000 | 30000 | 1.5 | 100 | 24000 | ... |
| GS42A | B214 | -F | ... | 19000 | 1.5 | 13000 | 22000 | 2.0 | 55 | ... | ... |
| GZ42A | A214 | -F | ... | 22000 | 2.5 | 16000 | 27000 | 7.0 | 60 | 22000 | ... |
| S5A | 43 | -F | ... | 21000 | 5.0 | 9000 | 23000 | 10.0 | 45 | 16000 | ... |
| SC51A | 355 | -T6 | ... | 37000 | 1.5 | 27000 | 43000 | 4.0 | 90 | 34000 | 10000 |
| SC64A | A108 | -F | ... | 23000 | Not required | 16000 | 28000 | 2.0 | 70 | 22000 | ... |
| SC64C | 319 | -F | ... | 26000 | Not required | 19000 | 27000 | 2.0 | 70 | 22000 | 10000 |
| SG70A | 356 | -T6 | ... | 33000 | 3.0 | 27000 | 40000 | 5.0 | 90 | 32000 | 13000 |
| SN122A | A132 | -T551 | ... | 31000 | Not required | 28000 | 36000 | 0.5 | 105 | 28000 | 13500 |
| | | -T65 | ... | 40000 | Not required | 43000 | 47000 | 0.5 | 125 | 36000 | ... |
| ZC60A | C612 | -F | ... | 28000 | 7.0 | 18000 | 35000 | 8.0 | 70 | ... | ... |

istics and is being replaced by AZ91C. Although the mechanical properties of a given alloy tend to be somewhat higher when cast in a permanent mold, this is not reflected in guaranteed minima for separately cast test bars, which is the same for both sand and permanent-mold castings.

The minimum specification values and typical mechanical property values for the several alloys which are commonly used for magnesium sand and permanent-mold castings are shown in Table 5.

## CONCLUSION

It is important that the designer consult with the foundryman in the choice of alloy, and this is particularly true in the case of large and intricate castings. In many cases an alloy with good casting characteristics and moderately high mechanical properties will result in a better casting, from a load-carrying standpoint, than an alloy which produces higher properties in separately cast test bars but has relatively poor casting characteristics. The foundryman is in a good position to advise on such factors.

Each of the alloys referred to in this paper is described adequately by a number of specifications including the Federal Specifications, the ASTM Specifications, and the Aeronautical Material Specifications. When the choice of alloy and casting method has been established, it is strongly urged that the designer and casting buyer select the proper specification of one of these specification agencies as the basis for the casting contract or order.

There may be cases where special specifications, drawn by the individual purchaser, may be necessary, but these should be worked out with the casting supplier.

## REFERENCES

1 "Cast Metals Handbook," American Foundrymen's Society, third edition, 1944.

2 "Casting Alcoa Alloys," Aluminum Company of America, 1951.

3 "Design Details for Aluminum," Aluminum Company of America, 1944.

4 "Designing With Magnesium," Aluminum Company of America, 1947.

5 "Engineering for Aluminum Alloy Castings," by T. R. Gauthier and H. J. Rowe, *American Foundryman*, vol. 13, February, 1948, pp. 27–36.

6 "Permanent Mold Castings," by Alfred Sugar, *Metals and Alloys*, vol. 21, April, 1945, pp. 1016–1028.

TABLE 3 PHYSICAL PROPERTIES OF SAND-CAST ALUMINUM ALLOYS

| Alloy designation: ASTM B26-52T | Alloy designation: Commercial | Condition or temper | Specific gravity | Weight, pci | Electrical conductivity, % IACS | Thermal conductivity at 25 C CGS units | Coefficient of thermal expansion deg F × $10^{-6}$: 68 F–212 F | 68 F–392 F |
|---|---|---|---|---|---|---|---|---|
| C4A | 195 | -T4 | 2.81 | 0.102 | 35 | 0.33 | 12.7 | 13.3 |
| | | -T6 | 2.81 | 0.102 | 35 | 0.33 | 12.7 | 13.3 |
| | | -T62 | 2.81 | 0.102 | 35 | 0.34 | 12.7 | 13.3 |
| | | -T7 | 2.81 | 0.102 | 47.6 | 0.43 | 12.7 | 13.3 |
| CG100A | 122 | -T2 | 2.95 | 0.107 | 41 | 0.38 | 12.3 | 12.6 |
| | | -T61 | 2.95 | 0.107 | 33 | 0.31 | 12.3 | 12.6 |
| CN42A | 142 | -T21 | 2.81 | 0.102 | 44 | 0.40 | 12.5 | 13.0 |
| | | -T61 | 2.81 | 0.102 | 33 | 0.32 | 12.5 | 13.0 |
| CS43A | 108 | -F | 2.79 | 0.101 | 31 | 0.29 | 12.2 | 12.7 |
| CS72A | 113 | -F | 2.92 | 0.106 | 30 | 0.28 | 12.3 | 12.8 |
| G4A | 214 | -F | 2.65 | 0.096 | 35 | 0.33 | 13.3 | 13.8 |
| G10A | 220 | -T4 | 2.57 | 0.093 | 21 | 0.21 | 14.0 | 14.4 |
| GS42A | B214 | -F | 2.65 | 0.096 | 38 | 0.35 | 12.7 | 13.3 |
| S5A | 43 | -F | 2.69 | 0.097 | 37 | 0.35 | 12.3 | 12.9 |
| SC51A | 355 | -T6 | 2.71 | 0.098 | 36 | 0.34 | 12.4 | 12.9 |
| | | -T51 | 2.71 | 0.098 | 43 | 0.40 | 12.4 | 12.9 |
| | | -T71 | 2.71 | 0.098 | .. | .. | 12.4 | 12.9 |
| SC64C | 319 | -F | 2.79 | 0.101 | 27 | 0.27 | 12.0 | 12.6 |
| | | -T6 | 2.79 | 0.101 | .. | .. | 11.9 | 12.4 |
| SG70A | 356 | -T6 | 2.68 | 0.097 | 39 | 0.36 | 11.9 | 12.7 |
| | | -T51 | 2.68 | 0.097 | 43 | 0.40 | 11.9 | 12.7 |
| ZG61B | A612 | -F | 2.81 | 0.102 | 35 | 0.33 | 13.4 | 13.8 |

TABLE 4 PHYSICAL PROPERTIES OF PERMANENT-MOLD CAST ALUMINUM ALLOYS

| Alloy designation: ASTM B108-52T | Alloy designation: Commercial | Condition or temper | Specific gravity | Weight, pci | Electrical conductivity, % IACS | Thermal conductivity at 25 C CGS units | Coefficient of thermal expansion deg F × $10^{-6}$: 68 F–212 F | 68 F–392 F |
|---|---|---|---|---|---|---|---|---|
| CG100A | 122 | -T551 | 2.95 | 0.107 | 34 | 0.32 | 12.3 | 12.6 |
| | | -T65 | 2.95 | 0.107 | 33.4 | 0.31 | 12.3 | 12.6 |
| CN42A | 142 | -T571 | 2.81 | 0.102 | 34 | 0.32 | 12.5 | 13.0 |
| | | -T61 | 2.81 | 0.102 | 33 | 0.32 | 12.5 | 13.0 |
| CS42A | B195 | -T4 | 2.80 | 0.101 | 33 | 0.32 | 12.2 | 12.7 |
| | | -T6 | 2.80 | 0.101 | 33 | 0.32 | 12.2 | 12.7 |
| | | -T7 | 2.80 | 0.101 | .. | .. | 12.2 | 12.7 |
| CS72A | 113 | -F | 2.92 | 0.106 | 30 | 0.28 | 12.3 | 12.8 |
| CS104A | 138 | -F | 2.95 | 0.107 | 25 | 0.25 | 11.9 | 12.5 |
| GS42A | B214 | -F | 2.65 | 0.096 | 38 | 0.35 | 12.7 | 13.3 |
| GZ42A | A214 | -F | 2.68 | 0.097 | 34 | 0.32 | 13.3 | 13.8 |
| S5A | 43 | -F | 2.64 | 0.095 | 37 | 0.35 | 12.3 | 12.9 |
| SC51A | 355 | -T6 | 2.71 | 0.098 | 39 | 0.36 | 12.4 | 12.9 |
| SC64A | A108 | -F | 2.79 | 0.101 | 37 | 0.34 | 11.9 | 12.5 |
| SC64C | 319 | -F | 2.79 | 0.101 | 27 | 0.27 | 12.0 | 12.6 |
| SG70A | 356 | -T6 | 2.68 | 0.097 | 39 | 0.36 | 11.9 | 12.7 |
| SN122A | A132 | -T551 | 2.72 | 0.098 | 29 | 0.28 | 11.0 | 11.3 |
| | | -T65 | 2.72 | 0.098 | .. | .. | 11.0 | 11.3 |
| ZC60A | C612 | -F | 2.84 | 0.103 | 40 | 0.38 | 13.1 | 13.6 |

TABLE 5 MECHANICAL PROPERTIES OF SAND AND PERMANENT-MOLD CAST MAGNESIUM ALLOYS

| ASTM alloy designation B80-51T[a] | Condition or temper | Minimum properties: Yield strength, psi | Tensile strength, psi | Elongation, % in 2 in. | Typical properties: Yield strength, psi | Tensile strength, psi | Elongation, % in 2 in. | Brinell hardness, 500 Kg-10 mm | Shearing strength, psi | Endurance limit, psi |
|---|---|---|---|---|---|---|---|---|---|---|
| AZ63A | -F | 10000 | 24000 | 4.0 | 11000 | 27000 | 6.0 | 51 | 18000 | 11000 |
| | -T5 | 11000 | 24000 | 2.0 | 15000 | 29000 | 4.0 | 55 | ... | 11000 |
| | -T4 | 10000 | 34000 | 7.0 | 13000 | 40000 | 15.0 | 53 | 18000 | 12000 |
| | -T6 | 16000 | 34000 | 3.0 | 19000 | 40000 | 5.0 | 71 | 20000 | 11000 |
| AZ91C | -T4 | 10000 | 34000 | 7.0 | 13000 | 40000 | 15.0 | 55 | ... | ... |
| | -T6 | 16000 | 34000 | 3.0 | 19000 | 40000 | 5.0 | 70 | 20000 | ... |
| AZ92A | -F | 10000 | 20000 | Not required | 14000 | 25000 | 2.0 | 65 | 18000 | 12000 |
| | -T5 | 11000 | 20000 | Not required | 17000 | 25000 | 1.0 | 69 | ... | 11000 |
| | -T4 | 10000 | 34000 | 6.0 | 14000 | 40000 | 10.0 | 63 | 20000 | 13000 |
| | -T6 | 18000 | 34000 | 1.0 | 22000 | 40000 | 3.0 | 81 | 22000 | 12000 |
| AM100A | -T6 | 17000 | 34000 | Not required | 19000 | 40000 | 1.0 | 69 | 22000 | 10000 |

[a] Specification B80-51T covers sand castings only, but mechanical properties in this table apply to both sand and permanent-mold castings.

# *Tolerances and Specifications for Precision Investment Castings*

By W. O. SWEENY

PRECISION INVESTMENT CASTINGS SALES DEVELOPMENT MANAGER, HAYNES STELLITE COMPANY, DIVISION OF UNION CARBIDE AND CARBON CORPORATION, KOKOMO, IND.

#### PRECISION CASTINGS

THE fact that precision castings can be made to close dimensions is particularly important in producing parts from alloys that have relatively high melting points, and that are difficult to machine, forge, or grind. Many aircraft parts, for example, are required in superalloys that cannot be produced economically in quantity by forging or machining. Such parts often can be investment-cast to the required shapes and sizes, with little or no subsequent finishing. In this way, precision casting eliminates the need for costly machining operations and also permits casting of shapes and contours that cannot be produced readily by other common methods. Sometimes the process is used in connection with simple machining operations. Where it is not practical to hold extremely close tolerances on certain surfaces, the casting often is made with a stock allowance for secondary machining operations.

At first it was thought that only small castings could be made by investment-casting. However, producers constantly are expanding their facilities to accommodate larger parts. Some castings as long as 20 in. and others up to 10 in. diam have been produced economically. The minimum size is limited only by the handling problem involved. Castings with a minimum dimension of as little as $^1/_4$ in. have been made successfully. The minimum weight of the casting also is limited by handling problems. Parts weighing as little as 0.002 lb have been produced. The maximum weight depends upon the method of pouring the metal. The current maximum for pressure-poured castings is approximately $4^1/_2$ lb and for conventional gravity-poured castings the maximum is about 25 lb.

The minimum wall thickness practical for production is 0.050 in., although a thickness of as little as 0.030 in. is possible in some cases where the area involved is small and limited. A minimum edge thickness of 0.012 in. can be obtained, provided there is a gradual taper, rather than an abrupt sectional change. On threads and serrations, a minimum radius of 0.005 in. can be cast. The minimum diameter practical for cored holes in thin sections is 0.050 in., but this depends a great deal on the amount of metal surrounding the hole. Certain castings with much smaller holes have been made.

#### HOW TOLERANCES AFFECT COSTS

Engineers working with the precision investment-casting process generally agree that a minimum acceptable tolerance for economical production is ±0.005 in. per in. on dimensions up to 3 in. On dimensions of $^5/_8$ in. or less, a tolerance of ±0.003 in. can be held. An accepted tolerance on angles is generally ±$^1/_2$ deg. Small holes, $^1/_4$ in. diam or less and approximately $^1/_2$ in. deep, can be held to a tolerance of ±0.003 in. with respect to diameter. Larger holes require a correspondingly larger tolerance.

Contributed by the Metals Engineering Division and presented at the Fall Meeting, Chicago, Ill., September 7-11, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed.

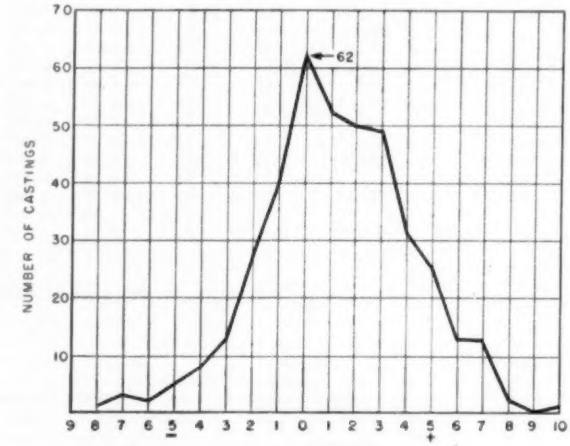



FIG. 1 DEVIATION OF DIMENSION *A* IN 0.001 IN.

These tolerances apply only to dimensions that are not located across part lines or on gated surfaces. Closer tolerances, which can be obtained under ideal conditions such as in a laboratory, are not yet practical on a commercial basis. Some precision-casting foundries undoubtedly will quote closer tolerances, but in general, those outlined will apply to most types of precision castings. If a particular part is such that only a few critical dimensions require close tolerances, the die sometimes can be designed so that the necessary tolerances can be held.

The designer should give careful consideration to all tolerances specified, because the closer the tolerance, the higher the final cost of the casting. For greatest economy, tolerances should be only as close as the application actually requires.

Briefly, this is how tolerances affect cost. The closer the tolerance, the more accurate the pattern must be. Often this means a high pattern cost. Next, special precautions must be taken in making the die. Once the casting is made, close tolerances require more expensive inspection and reduce the percentage of acceptable castings.

Fig. 1 gives an example of the way tolerances affect recovery. This is a graphical representation of the dimension *A* shown in Fig. 2. In this case, 397 castings were checked for dimension *A*, which is 0.750 in., ±0.010 in. The graph shows the results of 100 per cent inspection on this dimension. Since the tolerance was ±0.010 in., no casting was rejected because of failure to meet the required tolerance. However, if the tolerance were narrowed to ±0.005 in. on this dimension, 35 of the 397 castings, or 9 per cent, would have been rejected. A still closer tolerance would cause an even larger number of rejects.

This example is representative of small dimensions. As the dimensions increase, the spread increases; however, the graphic representation is similar. In the foregoing case only one dimension was considered. If there were more dimensions with

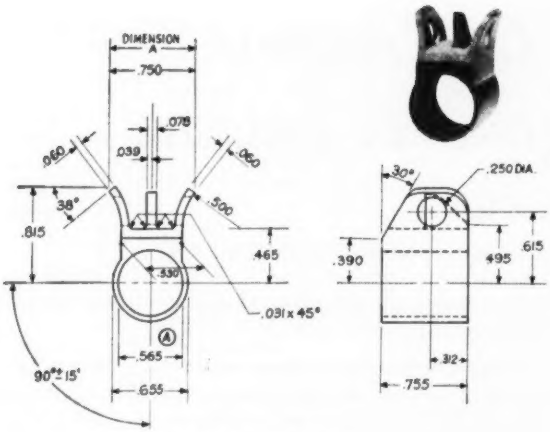


FIG. 2 GUN SIGHT

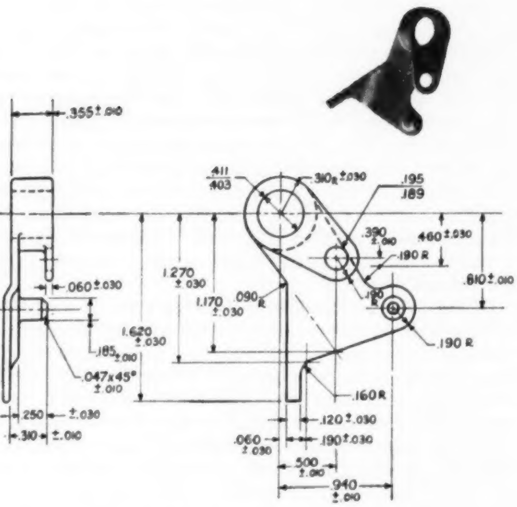


FIG. 3 LOCKING ARM

the same close tolerances, the recovery would be proportionately lower. Thus it is obvious that tolerances greatly affect recovery, and therefore, the cost of the casting.

The part shown in Fig. 3 has a number of tolerances. However, most of these tolerances are quite liberal, except for the tolerances on the holes, which are ±0.003 and ±0.004 in. These tolerances can be held, since the holes are not deep. After the part is cast, all that is necessary is to cut off the gates and do some light grinding. However, this part would be difficult to produce by other methods. Fig. 4 shows the plastic patterns used in making the part. In this case, two plastic patterns had to be assembled in order to obtain the intricate shape of the part.

The various blades and buckets that are cast for the aircraft industry are good examples of successful precision investment castings. Figs. 5 and 6 are sketches of typical aircraft parts. These sketches also illustrate the methods of targeting or dimensioning castings. Note that the part in Fig. 5 has five points that are used for checking dimensions and also for locating machining operations on the base. By having the locating point on the airfoil, the base can be machined in the same relation to the airfoil in all cases.

Fig. 6 shows another method of targeting. In this case, lugs are an integral part of the casting and are located outside the airfoil. This method makes it easier to grip the blade during inspection and machining. However, the results are not so accurate as in the first case, because if any of the lugs is nicked or bent, the base may not be located properly with respect to the blade.

In most cases, parts are designed originally for some production method other than precision-casting. In such cases, the design usually can be modified to make the part suitable for precision-casting. On the other hand, many design features that are costly to obtain by other methods of manufacture can be precision-cast readily at no extra cost. Thus best results are obtained when a part is designed particularly for production by the precision investment-casting process.

Designers should remember that any casting to be produced

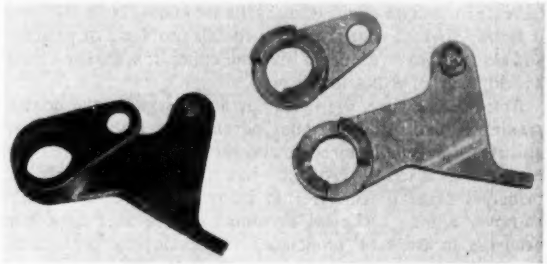


FIG. 4 PLASTIC PATTERNS USED IN MAKING LOCKING ARM

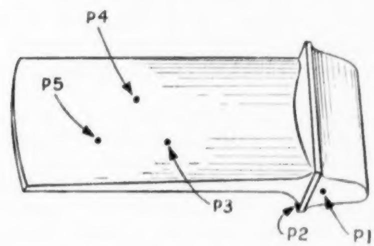



FIG. 5 TURBINE BLADE

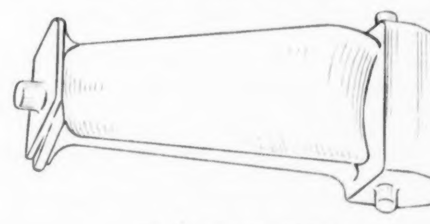


FIG. 6 TURBINE BLADE

by the investment method must have a draft allowance and must be gated and parted. A minimum draft of 1/2 deg should be allowed on parting surfaces. It is important to follow the rules of good casting procedure, such as using fillets instead of sharp corners and avoiding abrupt changes in section. While it is true that sharp corners, negative angles, and undercuts can be cast, this is possible only after experimentation and with more expensive tooling.

### SPECIFYING INSPECTION STANDARDS

An important factor in keeping down the cost of investment castings is making specifications as to inspection standards.

(*Continued on page 471*)

# *Developing Professional Consciousness in the Young Engineer in Industry*

By R. E. BURTON

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IT IS most appropriate that the Education Committee has focused our attention on professionalism. The need for a forthright discussion of the problem has never been greater. The growing shortages of engineering graduates, and the great increase in need for engineering skills are known to us all. But, it is less obvious that these day-to-day problems of personnel and skill cannot be divorced from our efforts toward the over-all development of professionalism.

At the same time, we must not underestimate the need for maximum utilization of the individual graduate engineer's abilities. Failure to meet this problem—indeed, failure to recognize it as a serious problem—has resulted in its becoming a principal cause of turnover in many concerns. The rate of turnover among technical personnel can be used as a fairly accurate measure of proficiency in developing professionalism.

Personnel interviews in the engineering department at du Pont reveal strong evidence in support of this fact. Let me quote here from a tabulation of reasons for resignation by engineers transferring to us from other concerns. We employed 153 such technical men during the first nine months of this year.

Of all reasons given for the change, 41 per cent gave, in their opinions, reasons associated with skills not being used to maximum advantage; other reasons—salary, 11 per cent; location, 7 per cent; traveling distance, 3 per cent; limited future in former position, 8 per cent; and "reason unknown," 30 per cent. Moreover, when we consider that a large share of those accounted for in the "limited future" and "reason unknown" categories can probably be included in the first group, the total percentage relating to poor utilization of skills is highly significant.

Experience at du Pont is not above reproach. Of those leaving the engineering department through October of 1952, 26 per cent left because of dissatisfaction with their work and feeling that their abilities were not being fully utilized.

These illustrations point to two important conclusions. First, industry must place its young engineers in the field of work for which they are educated and best suited. Secondly, once this is accomplished, there is a need for industry to give attention to greater utilization of their individual abilities.

Industry must also more fully recognize and meet its responsibilities in furthering the technical development of engineers and give greater assistance in their self-development.

An analysis from our experience in the engineering department leads to the conclusion that what really plagues industry is not a lack of professional *consciousness* in young engineers, but a need for continually promoting the development of professional *competence*.

Contributed by the Education Committee, Management Division, and the Junior Committee and presented at the Annual Meeting, New York, N. Y., Nov. 30 to Dec. 5, 1952, of The American Society of Mechanical Engineers.

My remarks, therefore, will be devoted to this particular aspect of the problem.

### GAPS TO BRIDGE FOR REACHING PROFESSIONAL COMPETENCE

In question form, the problem might be stated: What is the difference between a man who receives an engineering degree and a man who has satisfied the requirements of a professionally competent engineer? or, what gap must the graduate bridge to achieve professional competence? Our State Boards have given varied answers to this query. For example, in New Jersey—assuming the applicant has a degree in engineering—one requirement for a professional license is four years of "suitable professional experience," and the engineer must spend at least part of this time in responsible charge of engineering work. The graduate must also pass a three-part examination. If he has no degree in engineering, the applicant must perform twelve years of practical professional work acceptable to the State Board. Meanwhile, neighboring Delaware requires no written examination. Rather, the graduate's record is submitted to the Board, which then passes on his professional merit.

I could cite other examples to illustrate the lack of uniformity in license regulations. But one conclusion can be drawn: Possession of a license does not mean the same requirements have been met by all who qualify. Moreover, from a practical standpoint, companies usually demand standards of performance higher than those which are required to obtain a license. And there is the ever-present possibility that the State Boards may vary in the standards of accomplishment they prescribe for their applicants. Therefore, under the present conditions, licensing is not a realistic measure of professional competence.

### COMPARISON VERSUS CONTRAST IN PROFESSIONAL MEN

Whenever engineering professionalism has been discussed or written about in recent years, it has been a general practice to compare engineering with the professions of law and medicine. In both cases, but particularly in the medical profession, the graduate must serve an apprenticeship. Engineering graduates are reluctant to do so. A high percentage of young men with BS degrees already consider themselves professional engineers. But for the most part, they are trainees, not engineers, though they generally dislike that title. For this reason, industry must not only guide the engineering novice toward professional competence, but we must first make him aware that such status is not gained merely through possession of a degree.

In many other instances, law and medicine have probably been too rigidly *compared* with engineering, while observable *contrasts* hold much greater significance. The man-and-client relationship is often cited as one of the principal identifying marks of the "professional man." A direct relationship between the doctor and his patient is the general rule in medicine. However, most engineers seldom deal with individual clients. In the large majority, they are employed by corporations of

varying sizes. And even the consulting engineer deals in many instances with corporations, not individuals.

Even more significant is the basic difference with regard to professional responsibility. In engineering, there is a chain of responsibility for work accomplished. This means that only a small number of individuals in an engineering force are held directly accountable to the public, client, or concern involved while most of them are responsible to other engineers in the organization.

### PROFESSIONAL REQUIREMENTS

If, then, there are to be true gages of professional competence in engineering, we must first consider what industry requires of its engineers. Secondly, what can industry do to foster the degree of capability it demands?

With regard to industry's professional requirements, this general guide or yardstick might be established: Engineering professionalism, as measured by industry, is the degree of proficiency attained by the engineer in his work, which produces results of maximum benefit to his employer and the public. Professionalism, therefore, should be regarded as a continuing state of learning and exercise of judgment by which the engineer *can* be deposed from his status by his own indifference or static outlook.

Few of us would deny that there are gaps in experience and attitude which the young engineer must fill before he approaches professional competence of a high order. But clearly, neither the graduate with a sheepskin in hand, nor any veteran engineer in industry, should be permitted to claim professional status until he reaches and maintains the minimum requirements of experience and performance in his field of specialization.

It becomes apparent that several specific aspects of the young engineer's work will reveal the degree of professional capability he has attained. These basic areas can be examined profitably in this analysis.

First, there is the engineer's respect for his own time. Engineers must limit their efforts to real engineering work and shun semitechnical and clerical duties. Moreover, this responsibility necessarily weighs heavier on the graduate as he grows in professional stature. Industry can help this situation by carefully placing engineers in engineering jobs and by assigning tasks which involve technical solutions. I suggested earlier that we could not deal separately with the problem of professional development and our daily engineering needs. With regard to careful use of the engineer's time, this is particularly true. For, on the one hand, we have an increasing shortage of engineering graduates, and, on the other, a dearth of professional qualification in these graduates. Maximum use of their time in engineering is one remedy for both.

Secondly, economy of the employer's time and materials must be considered. This corollary follows logically, since only through its practice will maximum benefit accrue to employer and the public.

Next is each engineer's relationship with fellow engineers, craftsmen, and auxiliary groups. This point recalls one of the key comments made by educators in reports on their "Year-in-Industry" with du Pont. They have all been impressed with the importance of good human relations in the success and usefulness of technically trained people. As one educator expressed it: "In order to succeed, it is obvious that the ability to get along well with those with whom he works is as essential as technical knowledge."

Fourth, we must evaluate the quality of work performed by the engineer. Herein lies the real essence of professional competence. While other measures are individually significant for our analysis here, in practice they are all reflected in the end product produced—the research, the development, the design, the construction, the consultation service, or whatever it may be.

Fifth, we should observe the engineer's diligence in keeping abreast of advances in his profession. Today, engineers face the physical impossibility of absorbing all, or even a large portion of the technical innovations made and the current thinking in their fields. We can expect the professional man to devote a fair measure of his personal time and effort to self-improvement. Our presence here testifies to the fact that the professional societies serve as important sources of information.

Another basic consideration is the engineer's concern for the satisfaction and safety of the public in using his machines, devices, or structures. In this regard, one young engineer made a point in a published criticism of his "profession" not long ago which is worthy of some thought on our part. He observed that engineers are generally lacking in the desire to serve the public that is characteristic of the other professions. In supporting his claim, the graduate cited a survey by R. S. Aries & Associates of New York on "What Engineers Are Looking for in a Job." Results showed that the desire to serve the public was rated last among the eight job incentives listed.

However lacking the individual may be in this respect, one fact remains: To fully discharge his obligations, the young engineer must often think beyond his employer's immediate needs. Reference was made to the human barrier that separates the average engineer from his real client. He cannot be expected to overcome this obstacle, but rather to cultivate an awareness of it. From a practical standpoint, this means that he must think and act with serious regard for distant effects of his work, while satisfying his employer's direct needs.

### INDUSTRY'S RESPONSIBILITY

The hypothetical engineer we have been rating with these practical measures of professionalism cannot hope to pass the test unless he possesses one more essential characteristic. There must be motivation if we are to find evidences of competence. Other qualifications being equal, success in any endeavor is achieved in proportion to the motivating force responsible for the individual's effort. Again, referring to the chain of responsibility usually found in large organizations, the individual engineer's specific contribution might easily lose its identity in the end product. Recognition of accomplishment is important if motivation is to be fostered.

Adapting a maxim of human behavior to this discussion: Professional competence can be developed in your engineers only in proportion to the degree of professionalism exhibited by their superiors. Professional example by management and supervision, then, is foremost. To refer to one earlier point for an illustration, the young engineer can hardly be expected to economize on the employer's time and materials if the employer himself appears to be squandering them.

Counseling is just a step beyond example. The extent of its use constitutes a rough measure of management's interest in personnel development. A large share of the time spent counseling graduate engineers should be devoted to discussing the individual's self-improvement along professional lines. There are several areas in which supervisors can be active and convincing. Management can co-operate in furthering the young engineer's formal education. We can explain the value of personality broadening and emphasize the merit of an active responsible participation in professional societies and community affairs. Moreover, this matter of counseling is too important to be conducted in an off-hand casual manner. An occasional word of advice or friendly inquiry will not do. An established

counseling pattern is one of the most valuable techniques we can use.

Most young engineers' feelings go deeper than the resentment at being called "trainees" that I mentioned earlier. They are anxious for true recognition. Each says, in effect, "If I am not a professional engineer now (meaning at graduation), exactly when *will* I be one?" Based on the thoughts I have expressed to this point, we would answer by explaining the interdependence of professional competence and maximum benefit from work accomplished. But, young engineers would be disappointed in such a reply, since it fails to reckon with professionalism in terms of months and years. They naturally have a calendar goal in mind.

The new graduate, then, does not readily accept the idea that engineering professionalism boils down to a constant display of excellence. Meanwhile, he badly needs the "feel" of professionalism. Industry can do this: Give the graduate the *outward bearing* of a professional man. Can't we make a special point of referring to past engineering accomplishments—particularly those within our immediate sphere—so that these young men will be more aware of the heritage of their chosen field?

Then, there is job rotation to consider. This practice removes the mystery of functions which are unfamiliar to the engineer. Also, changing assignments gives the engineer a feeling of capability and breadth of experience. And somewhere along this line of experience, he will find that capability itself is really the professional goal he is after. Then, he will give outward bearing its proper due.

Finally, let us consider in some detail what should be industry's major contribution toward the development of professional competence—a planned program of progress for the young engineer. Indeed, where there is no such program, we might look in vain for evidence of professionalism in those aspects of the engineer's work which I have outlined. Also, professional example, counseling, and "outward bearing" become hollow tributes to engineering professionalism if they are not complemented by industry-sponsored training.

### DU PONT ENGINEERING DEPARTMENT DEVELOPMENT PROGRAM

To illustrate what is being done in this respect in one situation, permit me to make specific reference to the industrial organization most intimately known to me. The du Pont Company employs some 87,000 persons. Our Engineering Department employs approximately 2000 engineers. We are one of the thirteen auxiliary departments which provide services for ten industrial departments, each responsible for research, manufacturing, and sales of a product line.

Currently, the engineering department is spending about one-quarter million dollars annually to advance the technical maturity of its young engineers. The transitional training which we provide is designed to strengthen specific weaknesses observed. No engineering department or group can hope to detect and deal effectively with every individual weakness existing at a given time. However, we can develop, through careful planning, programs which encompass the more vital needs of the young graduate. At du Pont, we have found these to be the most prevalent areas of deficiency among graduate engineers:

Motivating characteristics

Ability to apply theoretical knowledge to practical situations

Leadership and human-relations skills

Personality and judgment faults

I would like to refer here to some of the training courses we give in our over-all program and point out briefly the gaps they help fill.

First is *Orientation*, which describes the engineer's place in industry and his relation to all other segments of the organization.

Our *Cost Reduction* training gives him a better appreciation of engineering economics in industry and acquaints him with cost-control methods and indicates how economies can be effected.

*Job Training* presents the practical application of engineering technology to industrial problems. We outline the functions of the organization and responsibilities of the individuals. The young engineer is also introduced to the modern methods and tools currently used in his profession.

Training in *Planning* is given every engineer. Here, we review in detail the methods pertaining to planning and scheduling. Many young engineers are trained in *Work Simplification*.

That du Pont places particular emphasis on *Safety Training* is proved by our safety record. We intend to preserve our safety standards by indoctrinating young engineers in safety philosophy and means of preventing and correcting safety hazards.

Under the various forms of an *apprentice-type system*, each young engineer is assigned to work with experienced engineers, whereby they learn the applications of engineering techniques to practical problems.

Reference has already been made to job rotation. In our department it continues until the young engineer has a broad concept of the work accomplished by the many branches of engineering. For example, in our Construction Division, job-rotation programs are planned to give the new engineer an understanding of the tools, construction methods, and viewpoints of construction mechanics. Moreover, job rotation enables the graduate—so often undecided—to choose the kind of work he likes best, and aids placement in the type of work for which he is best fitted. Satisfactory job placement is a "must" if maximum benefit is ever to be realized.

*Leadership training* courses are initiated early in the engineer's career with du Pont. Those graduates who display leadership potential are given extensive formalized training and practice in leadership skills.

Off-the-job *academic training* is encouraged through extension programs offered by the University of Delaware with some financial aid by the Company.

### CONCLUSION

These are only representative examples of our training activities. Certainly I do not intend to imply that these are the ideal areas to be exploited in every situation. Many factors differentiate industries which are commonly concerned with professional development. The number of engineers employed, stage of growth of the particular concern, complexity of its engineering needs, characteristics of its engineering personnel—there are many more. The crux of the matter is that each company, regardless of size, must have a planned program geared to its own needs and those of its engineers.

The thoughts I have attempted to develop do not lead to any formula answer to the problem at hand. There is no such thing as a master pattern for all to follow in molding professional engineers. Rather, we must all recognize that, in the final analysis, it is increasing competence we seek in industry. And when our young graduates bridge this gap, we need be troubled no longer by the vagueness of professionalism. For then, if ever, our engineers *will be* professional engineers.

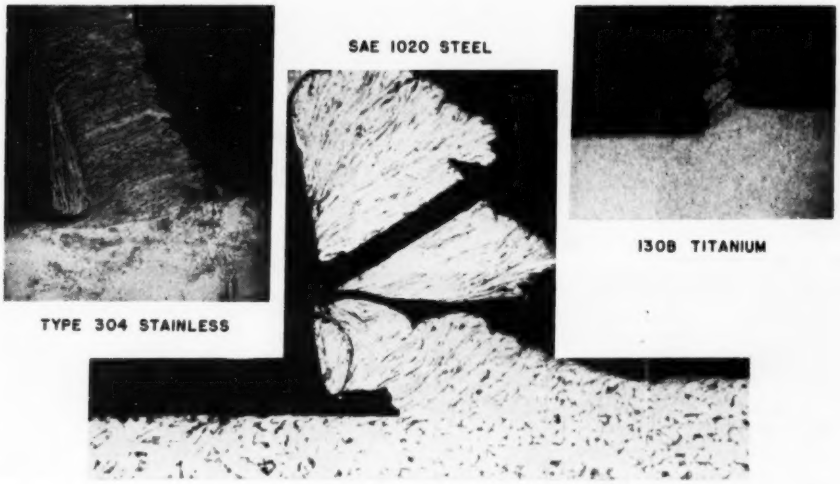


FIG. 1 CHIP FORMATION VERSUS MATERIAL CUT

(Cutting conditions: At end of shaper stroke with 9-in. stroke, 9 strokes per min, 0.005-in. depth of cut, $^1/_4$-in. width of cut. Tool signature: 8, 0, 6, 3, 0, 0, 0. Magnification ×50. SAE 1020 steel, nital etch; Type 304 stainless steel, electrolytic chromic-acid etch; Type 130B titanium, 48 per cent hydrofluoric acid in glycerine etch.)

# CUTTING CHARACTERISTICS *of* TITANIUM *and* ITS ALLOYS

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ALLOYS of titanium combine high strength with relatively lightweight and good corrosion resistance. These facts coupled with rapid increases in supply have caused considerable speculation on not only the functional applications but also on the fabrication of these alloys for the many products being considered. Machining usually plays an important part in early industrial experience with new metals since the larger quantities of parts which provide the greatest stimulus for the development of successful forging, casting, and other nonmachining techniques come later. This has been true also with the titanium alloys.

Lacking in precedents for cutting practice, it is understandable that various shops differed widely in their initial attempts at machining these alloys. It is also understandable that many conflicting reports resulted from their efforts. It was said that titanium cut like stainless steel; that it work-hardened rapidly; that it couldn't be tapped; that it couldn't be hacksawed; that it could be hacksawed but it couldn't be cut with abrasive cutoff wheels, and so on.

An investigation has been undertaken to evaluate the unique and pertinent cutting characteristics of titanium and its alloys with the final objective of designating necessary changes in commercial practice in regard to tools, size of cut, speed, and the like. This paper presents observations from some of the earlier phases of the investigation. These phases were designed to reveal and emphasize those aspects of the problem which would require comprehensive investigation. For the purpose of giving emphasis, as well as serving as a basis for comparison, the paper also presents the results obtained with 18-8 stainless steel and hot-rolled SAE 1045 steel cut at the same conditions as the titanium alloys.

## PRELIMINARY OBSERVATIONS

The laboratory phases of the program were preceded by general attempts to cut RC 130B titanium (contains 4 per cent aluminum and 4 per cent manganese) by ordinary shop methods. By this approach it was possible to turn, mill, shape, drill, ream, hacksaw, bandsaw, form-turn, and part this alloy. It was observed that feeding forces were unusually high, temperatures were high, chips were abnormally thin, and exceptional machine rigidity was required both to start and to sustain cutting.

Fig. 1 shows the results obtained from the first laboratory study of the program. These are photomicrographs of chip-formation specimens prepared in a shaper by mounting 3-in-long specimens in a vise so that the tool lacked about $^1/_2$ in. of completing the full length of cut, thus leaving the chip intact with the work specimen. All three views are at the same magnification; consequently, the first and most obvious impression is the very thin chip produced by the RC 130B titanium

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Contributed by the Research Committee on Cutting Fluids, Research Committee on Metal Cutting Data and Bibliography, and the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

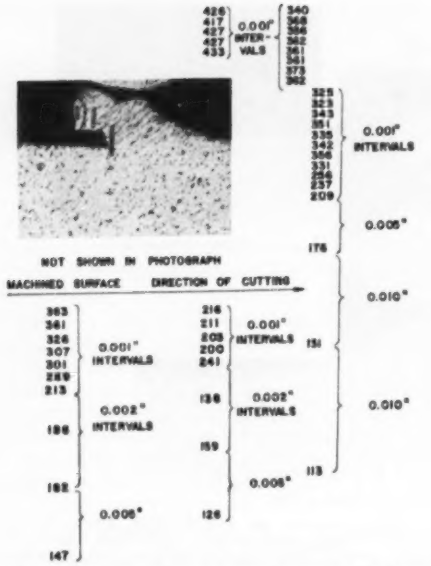


FIG. 2 TUKON HARDNESS OF CUTTING REGION FOR SAE 1020 STEEL

(Cutting conditions: Same as Fig. 1. Tukon operation: 100-g load, Knoop penetrator. Tests made on same section of SAE 1020 steel shown in Fig. 1.)

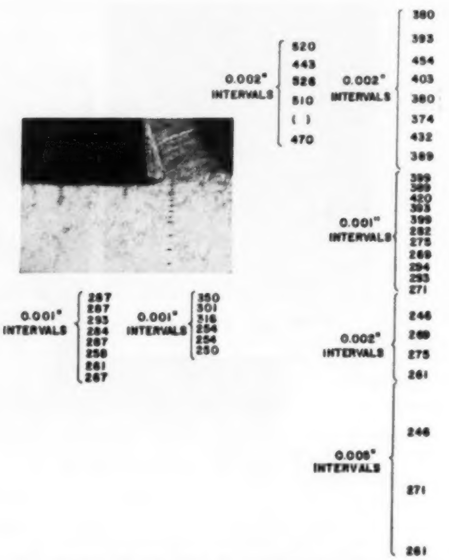

FIG. 3 TUKON HARDNESS OF CUTTING REGION FOR TYPE 304 STAINLESS STEEL

(Cutting conditions: Same as Fig. 1. Tukon operation: 100-g load, Knoop penetrator. Tests made on same section of Type 304 stainless shown in Fig. 1.)

compared to both the Type 304 stainless steel and the cold-rolled SAE 1020 steel. This difference is accompanied by corresponding differences in the shear angle as would be expected. The titanium shows a large shear angle relative to the direction of cutting while both the stainless and the SAE 1020 steels cut with much smaller angles.

The third factor of interest in a comparative test of this type is the work-hardening or distortion of the microstructure. No distortion is visible on the titanium except in the chip and even that is pretty well localized in the distinct cleavage lines. Microscopic examination showed no distortion of the microstructure near the cut surface except at ×1000. The distortion in the steels, however, is so great that it is difficult to recognize many features of the original structure in the chip. Initial slippage is evident in the stainless steel in some grains quite remote from the shear zone, indicating the extent and depth of penetration of the stress. The change in hardness associated with this distortion is substantial as pointed out later in Figs. 2 to 4, inclusive.

Certain tentative conclusions can be inferred from the comparative information shown in Fig. 1. They are that when cutting grade 130B titanium:

(*a*) Unit pressure on cutting tool will be higher.
(*b*) Temperature at tip of cutting tool will be higher.
(*c*) Surface roughness resulting from "smear" on work surface will be less.

Conclusion (*a*) is evident from the very small contact area between the chip and the cutting tool compared to those obtained with both the 18-8 stainless and the low-carbon steel at the same size of cut and cutting conditions.

That the temperature will be greater (conclusion *b*) is influenced by two factors: The presence of a built-up edge with the steels reduces the temperature level before the heat reaches the cutting tool. Also, owing to the built-up edge, the heat is distributed over a considerably greater area thus reducing the concentration of heat and the probability of destructively high

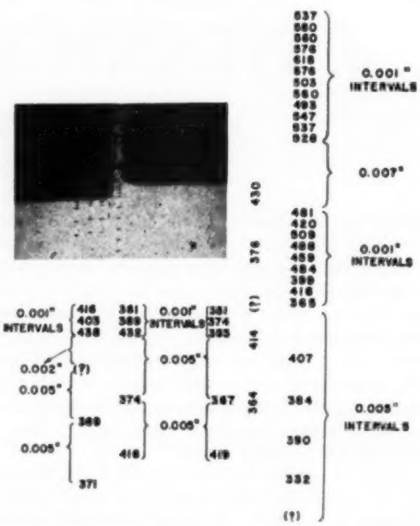

FIG. 4 TUKON HARDNESS OF CUTTING REGION FOR TYPE 130B TITANIUM ALLOY

(Cutting conditions: Same as Fig. 1. Tukon operation: 100-g load, Knoop penetrator. Tests made on same Section of Type 130B titanium shown in Fig. 1.)

temperature. Conclusion (*c*) is obvious since no smear metal appears on the cut surface.

Figs. 2, 3, and 4 show the results of microhardness surveys of the same machining specimens shown in Fig. 1. The unstrained material of the SAE 1020 steel showed a hardness a little over 100 while the built-up edge was hardened to an average of 426, an increase of over 300 per cent. Two separate regions of the chip showed average hardness numbers of 338 and 360, respectively, with increasing amount of distortion,

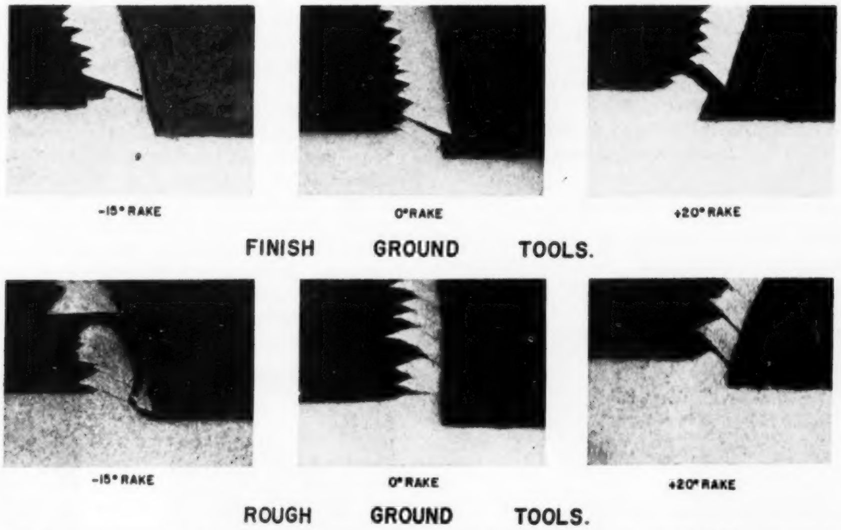


FIG. 5 CHIP FORMATION VERSUS TOOL RAKE ANGLE AND SURFACE FINISH FOR TYPE 130B TITANIUM ALLOY

(Rough-ground tools 31–50 microinches, and finish-ground tools 0–1.3 microinches surface roughness. Cutting conditions: At end of shaper stroke, 9-in. stroke, 9 strokes per min, 0.005 in. depth of cut, $^1/_4$-in. width of cut; magnification ×50.)

It is to be noted also that work-hardening was manifest in higher-hardness readings to a depth of at least 0.016 in.

Fig. 3 shows similar hardness readings for the Type 304 stainless steel. The body hardness averaged 260 while the built-up edge averaged 494, an increase of 90 per cent. The chip showed an average of 400 or an increase of 54 per cent over the body hardness.

The hardness-traverse results for titanium 130B are shown in Fig. 4. The body hardness averaged 376 while the chip averaged 551, an increase of only 46 per cent compared to 54 per cent and 250 per cent for the 18-8 and SAE 1020, respectively.

### EFFECT OF TOOL RAKE ANGLE AND SURFACE FINISH

The absence of a built-up edge makes the large shear angle a serious problem in view of the high temperatures and pressures that can result from this combination. Since the presence of a built-up edge can reduce both temperature and pressure on the cutting tool, an attempt was made to induce one for this purpose even though some sacrifice in surface finish might have to be made. Fig. 5 shows the results of this attempt.

Using the same general procedure as in Fig. 1, two sets of shaper tools were prepared representing a range of rake angles and two levels of surface roughness. Both sets of tools consisted of three tools ground by the most careful methods available and resulted in a roughness level of 0 to 1.3 microinches. The second set, designated as "rough-ground" tools, were machine-ground with coarse-grit wheels resulting in a roughness level of 31 to 50 microinches; this level is about as rough as ordinarily would be accepted in a shop. In both instances the grinding marks were oriented parallel to the cutting edge so as to exert the maximum influence on pressure welding.

It will be noted that all chips produced by these tools were Type 1 segmental chips like those produced earlier by the 130B titanium. The obvious result is that the attempt to produce a built-up edge failed, at least in the sense that a built-up edge is retained. However, it will be noted that something comparable to a built-up edge was trapped at least momentarily with the —15-deg-rake rough-ground tool as shown at the lower left in the figure. It is not believed that this phenomenon persisted for any significant period of time although there is evidence that it may have occurred relatively frequently, but perhaps only in a partial state of development. It will be noted that shear-cleavage surfaces occur at least once in every chip of Fig. 5, except those obtained with the 20-deg-rake tools. These surfaces are oriented obliquely relative to the underside of the chip. (Further reference is made to this phenomenon later in connection with Figs. 7 and 9.)

TABLE 1 SHEAR ANGLES FOR RC 130B TITANIUM CUT DRY

| | Rake angle | | |
|---|---|---|---|
| | —15 deg | 0 deg | +20 deg |
| Smooth-ground tools | 22 | 31 | 42 |
| Rough-ground tools | 22 | 29 | 43 |

The shear angles were measured for each of the conditions represented in Fig. 5; the results are shown in Table 1.

If the current theories relating shear angle, coefficient of friction, and rake angle are correct, then the widely different roughness between the two sets of tools did not produce any appreciable change in the effective coefficient of friction.

However, there is an obvious difference in the frequency and pitch of the cleavage surfaces, indicating that the difference in roughness did exert some influence. It is difficult to comprehend how this could be effected except through a change in either the level or the behavior pattern of friction.

Reference to Table 1 shows that the increments of shear angle are approximately one half the corresponding increments of rake angle. The calculated coefficient of friction from cutting-force tests made on RC 130B titanium is approximately 1.0. If it were assumed that the rake angle has little effect on the coefficient of friction, then the data in Table 1 conform quite closely to the original theory of Ernst and Merchant (1)[3] and the modified theory of Merchant (2) wherein the relationship of the shear angle $\phi$, the friction angle $\beta$, and the rake angle $\alpha$ are, respectively, expressed as

$$\phi = 45 - \beta/2 + \alpha/2 \qquad [1]$$

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

$$\phi = \frac{{}^{*}\cot^{-1}(K)}{2} - \beta/2 + \alpha/2 \ldots\ldots\ldots\ldots [2]$$

*$K$ expresses the rate of influence of normal stress $\sigma$ on the shear stress $\tau$ as given in the equation $\tau = \tau_0 + K\sigma$. The maximum value of the first term of Equation [2] is 45 deg when $K = 0$.

Substituting $\beta = 45$ deg and $\alpha = 0$ deg into Equation [1] gives

$$\phi = 45 - 45/2 = 22^1/_2 \text{ deg}$$

This is substantially lower than either the 29 deg or the 31 deg shown for the zero-rake-angle tools. Similar substitutions into the shear-angle equations proposed by others leads to the results obtained in Table 2.

TABLE 2 CALCULATED SHEAR ANGLE

| Author | Bibliography reference | Equation | $\phi$ deg |
|---|---|---|---|
| Stabler | 3 | $\phi = 45 - \beta + \alpha/2$ | 0 |
| Lee and Shaffer | 4 | $\phi = 45 - \beta + \alpha$ | 0 |
| Hucks | 5 | $\phi = \frac{45 - \tan^{-1} 2\mu + \alpha}{2}$ | 12 |

It can be seen from Table 2 that some of the other current theories are in substantially less agreement than that of Ernst and Merchant. Recently, Shaw, Cook, and Finnie (6) produced an extension of the theory wherein a new term $\eta'$ was added as follows

$$\phi = 45 + \eta' - \beta + \alpha$$

This term $\eta'$, it is claimed, reflects the influence of the degree of constraint manifest in the rake angle, on the effective hardness of the chip and this in turn affects the coefficient of friction in the usual manner to result in higher coefficients with higher rake angles. Term $\eta'$ cannot be determined directly from the photomicrographs in Fig. 5 but it is related to the oblique angle which the plane of principal shear makes with the bottom of the chip. This is designated as the angle $\eta$ and is related to $\eta'$ as follows

$$\phi = \eta + \alpha + \eta' \ldots\ldots\ldots\ldots [3]$$

$$= 45 - \beta \ldots\ldots\ldots\ldots [4]$$

$$\phi = 45 + \eta' - \beta + \alpha \ldots\ldots\ldots\ldots [5]$$

Therefore the angle $\eta$ should be equal to zero if the coefficient of friction is equal to 1.0. The average value of $\eta$ is 20 deg for which the friction angle would have to be equal to 25 deg or $\mu = 0.466$ to conform to the theory. If it were assumed that $\mu = 0.466$, then $\eta'$ would be approximately $-13$ deg and $\phi$ would be equal to 7 deg.

Thus it appears that there is something unique about the cutting behavior of titanium since the theories advanced to date predict the cutting behavior of other metals much more accurately than they do for titanium. It is quite possible that these new alloys may by contrast provide the information needed to reveal the significant discrepancies in existing theory. However, it is not the purpose of this paper to dwell on this point although some additional evidence along this same line will be presented in a later figure, in the hope that it may be useful in providing leads for further extension of metal-cutting theory.

Microscopic examination of the specimens shown in Fig. 5 revealed significant differences in the regularity and smoothness of the cut surface as they appear in cross section. This led to examination of the surface at the point where the tool entered the cut. The results are shown in Fig. 6 for the "smooth-ground" tools. They indicate that there is an initial loss of depth of cut proportional to the force normal to the cutting direction. In the case of the +20-deg-rake angle, the normal or thrust force is low enough relative to inherent damping so that the pulsating nature of the cutting force is reflected in the work surface beyond the entrance. On the other hand, this phenomenon appears to be damped out completely with both the zero and the $-15$-deg-rake angles. The loss of depth of cut is substantially greater than that observed in steel despite the fact that the force in the direction of cutting is substantially less than for a steel of corresponding strength. This may be due to an exceptionally high coefficient of friction which has not been established as yet, or it may be related to residual cutting forces at zero size of cut considered as a limit approached from finite sizes of cut. An interesting approach to this aspect of the problem was proposed recently by Thomsen, Lapsley, and Grassi (7).

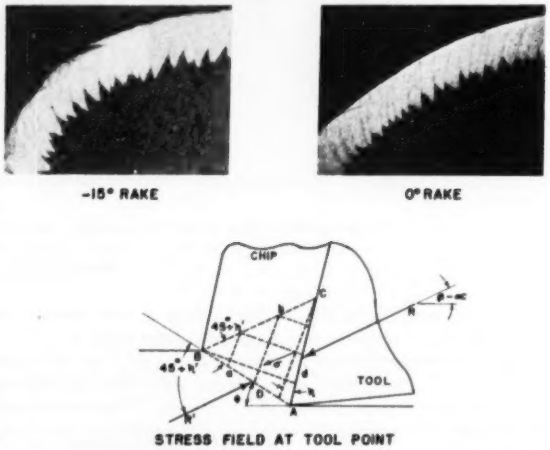


FIG. 7 CHIPS SHOWING TWO SURFACES OF SHEAR, FROM $-15$-DEG AND 0-DEG RAKE ANGLE, FINISH-GROUND TOOLS FOR TYPE 130B TITANIUM ALLOY SHOWN IN FIG. 5

(Depth of cut 0.015 in.; magnification ×50.)

Fig. 7 shows two views of additional portions of the chips obtained with the smooth-ground tools. These illustrations reveal the persistence of the surfaces of principal shear as they appear adjacent to the underside of the chip. This is the only instance in the authors' experience where this phenomenon has been observed except in the case of low-carbon steel cut at very low speeds and even in the latter instance the indication has been very superficial.

In the lower part of Fig. 7 there is a sketch of the stress field indicated by Shaw, Cook, and Finnie (6). The mutually perpendicular dashed lines rep-

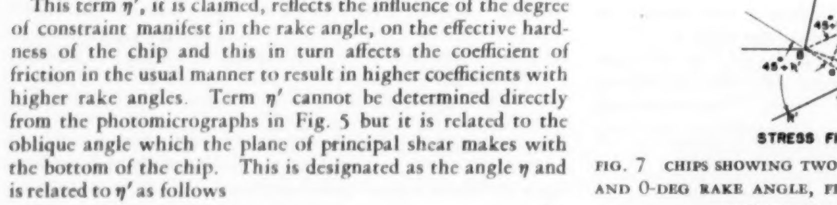


FIG. 6 ENTRANCE CONDITIONS SHAPER CUT VERSUS RAKE ANGLE FOR TYPE 130B TITANIUM ALLOY USING FINISH-GROUND TOOLS

(Cutting conditions and workpiece are the same as in Fig. 5; magnification ×50.)


FIG. 8 CHIP FORMATION VERSUS TITANIUM ALLOY FOR ALLOYS 75A, 130B, 150A

(Cutting conditions: At end of shaper stroke, 4-in. stroke, 9 strokes per min, 0.015-in. depth of cut, 1/4-in. width of cut. Back-rake angle of tool +20 deg; magnification ×50.)

resent the surfaces of principal shear stress peculiar to the theory advanced by these authors. The similarity of the cleavage surfaces, shown in the photomicrographs, to the orientation of one of the surfaces of principal stress is most interesting.

### CHIP FORMATION VERSUS TITANIUM ALLOY

Chip-formation studies with shaper cuts were the first to be made when the Ti 75A and Ti 150A grades of titanium became available. However, the test conditions were revised to overcome objections to some of the earlier tests on RC 130B. Principally, this revision consisted of an increase of the depth or thickness of cut from 0.005 in. to 0.015 in. to minimize the effect of the blunting which was evident near the cutting edge. The results of these tests are shown in Fig. 8. It will be noted that, as before, the RC 130B produces a distinct, Type 1, segmental chip while the Ti 150A produces a distinct Type 2 chip. The Ti 75A is intermediate between these two in that it produces substantially a smooth, continuous chip but it also shows some tendency toward segmentation. All three alloys are similar in regard to relatively thin chips and correspondingly large shear angles. In this respect, RC 130B still produces the largest shear angle while the Ti 75A gives the least and the Ti 150A is intermediate. The basis for the rather extreme difference in behavior as between the RC 130B and the Ti 150A is not evident from any data obtained up to this time. This information is presented for whatever intrinsic value it may have and in the hope that others may contribute toward an explanation of the differences in behavior.

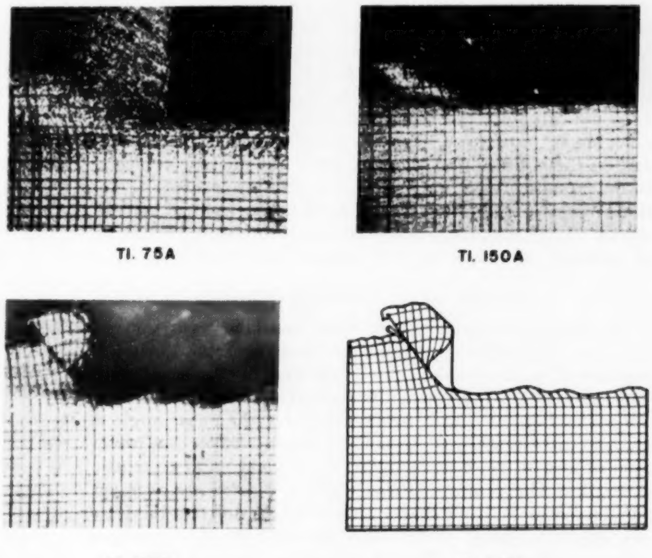


FIG. 9 GRID SPECIMENS SHOWING UNIT DISTORTION AND EVIDENCE OF LATERAL STRESS IN CHIP AND WORK MATERIAL FOR THREE TITANIUM ALLOYS

(Grid spacing 0.003 in. in both directions. Lower right figure is a tracing of lower left figure—130B. Cutting conditions: Same as Fig. 8 except total width which was 0.200 in. Rake angle of tool = 0 deg; magnification ×50. Photographed with polarized light.)

### MECHANISM OF CHIP FORMATION

A further extension of the chip-formation tests is shown in Fig. 9. Two specimens of each material were prepared for shaper cuts. They were 0.150 in. thick, 1/2 in. high, and 5/8 in. long. In addition, a 30-deg × 0.075-in-wide bevel was machined on one corner parallel to the 5/8-in. length. The 1/2-in. × 5/8-in. side opposite the bevel was scribed with a 0.003-in-square grid using gage blocks and a gage scriber. In conducting the tests, each pair of specimens was clamped in a vise with the scribed surfaces contacting each other under the pressure exerted by the vise. After a clean-up cut, a test cut was made in such a manner that the tool was stopped midway of the 5/8-in. length. A two-part chip was formed at a depth of 0.015 in. and a total width of approximately 0.200 in. The cutting tool was a 1 1/4-in-square solid tool ground for zero rake angle. Strain gages were mounted directly on the tool so that both the thrust and cutting components could be indicated. The results are shown in Table 3.

It will be noted that the coefficient of friction for the titanium alloys is approximately 1.0 while it is significantly lower for the two other alloys.

Illustrations of the grid surfaces of the specimens are shown in Fig. 9. The use of polarized light in making the pictures apparently assisted in identifying the existence of substantial plastic strain ahead of the usual shear plane. It is distinctly evident in all three types of titanium; it was even more evident and more extensive in Type 304 stainless and SAE 1045 steel although views of these specimens were not included in this figure. No attempt will be made at this writing to extend the theory to explain the influence of this phenomenon on the cutting behavior. However, it is appropriate to call attention to certain implications regarding current theories.

TABLE 3 CUTTING FORCES FOR GRID SPECIMENS

| Work material | —Forces, lb— Fc | Fn | Coefficient of friction | Thickness of cut, in. | Width of cut, in. |
|---|---|---|---|---|---|
| Ti 75A | 851 | 840 | 0.99 | 0.0127 | 0.186 |
| RC 130B | 667 | 652 | 0.98 | 0.0164 | 0.186 |
| Ti 150A | 894 | 830 | 0.93 | 0.0132 | 0.163 |
| 304 S.S. | 1268 | 1010 | 0.80 | 0.0086 | 0.192 |
| SAE 1045 | 1038 | 760 | 0.73 | 0.0146 | 0.186 |

Present theory assumes that the metal remains elastic until it enters the shear zone identified with what has been commonly called the shear plane. This is clearly not the case at all if the evidence shown in Fig. 9 is representative of metal cutting. Assuming the evidence to be valid, it means that the stress level has gone beyond the yield or flow point, thus indicating that it is substantial and must be considered in any theory relating the determinants of the shear angle and cutting forces.

Further, the fact that a differential volume of metal passes through such a stress field prior to the shear plane, means that it can undergo considerable strain hardening. In addition to this, the shape of the stress field indicates the possibility of different amounts of strain hardening resulting from different paths through the field. Assuming the existence of these possibilities, it means finally that there may be a considerable variation in the shear-flow stress across the shear plane, resulting in higher average stress and a major shift in the position of the resulting forces. Future extensions of the theory will be more difficult since the problem cannot be treated either as a plane-stress problem or a plane-strain problem. However, despite these difficulties, the very nature of the new evidence shows promise of assisting greatly in explaining apparent deviations of existing data when considered in the light of current theory. It is hoped that the uniqueness of the cutting behavior of titanium will shed further light on the correct theory.

### CUTTING VERSUS PHYSICAL PROPERTIES

The tensile properties of the several materials being investigated in the machining program are shown in Table 4. In the conduct of such a program, trial correlations are made as a routine matter. That particular approach produced the results shown in Fig. 10. This figure correlates the shear angle $\phi$ with a ratio formed by the product of the ratio of per cent reduction of area to per cent elongation and yield point to tensile strength. The values of shear angle as plotted are averages obtained from multiple shaper tests in which different lubricating conditions were used. Thus the averages also represent average performance. There is no obvious basis for this correlation and so it is presented in the interest of stimulating discussion and bringing forth additional evidence either to confirm or disprove it as a valid trend.

TABLE 4 TENSILE PROPERTIES OF WORK MATERIALS

| Material | Sample number | Yield strength,[a] psi | Tensile strength, psi | Breaking strength, psi | Elongation, per cent | Reduction of area, per cent |
|---|---|---|---|---|---|---|
| 304 SS | 1 | 37500 | 85500 | 55000 | 64.5 | 77.4 |
| 304 SS | 2 | 41000 | 85700 | 54500 | 62.7 | 77.4 |
| SAE 1045 | 1 | 48600 | 101200 | 91000 | 21.5 | 33.0 |
| SAE 1045 | 2 | 48800 | 101800 | 92500 | 21.7 | 34.4 |
| SAE 1045 | 3 | 53000 | 101700 | 93500 | 22.5 | 34.6 |
| Ti 75A | 1 | 60000 | 82000 | 66000 | 28.0 | 47.1 |
| Ti 75A | 2 | 57400 | 82100 | 65500 | 28.5 | 48.6 |
| Ti 75A | 3 | 57700 | 82000 | 65500 | 27.7 | 45.8 |
| RC 130B | 1 | 139000[b] | 155500 | 122500 | 18.5 | 41.9 |
| RC 130B | 2 | 139400[b] | 155000 | 126200 | 17.7 | 37.9 |
| RC 130B | 3 | 139400[b] | 155200 | 121700 | 18.3 | 45.3 |
| Ti 150A | 1 | 131700 | 141000 | 97200 | 25.0 | 55.8 |
| Ti 150A | 2 | 132500 | 140200 | 99200 | 24.7 | 54.5 |
| Ti 150A | 3 | 130000 | 140400 | 97400 | 25.0 | 55.1 |

[a] Yield strength determined by 0.2 per cent offset method.
[b] Yield-point value.

TABLE 5 BHN AND MEYER EXPONENTS

| Work material | Bhn[a] | Meyer exponent[b] |
|---|---|---|
| Ti 75A | 217 | 2.41 |
| RC 130B | 331 | 2.37 |
| Ti 150A | 302 | 2.27 |
| 304 SS | 174 | 2.32 |
| SAE 1045 | 201 | 2.25 |

[a] 3000-kg load.
[b] Load = $ad^n$.

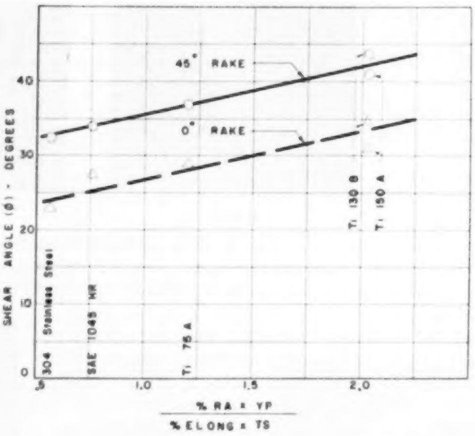


FIG. 10 AVERAGE SHEAR ANGLE AS A FUNCTION OF TENSILE PROPERTIES FOR FIVE MATERIALS, SEVERAL DEPTHS AND WIDTHS OF CUT, USING CARBON TETRACHLORIDE, WHITE MINERAL OIL, SULPHURIZED OIL, AND DRY CUTTING

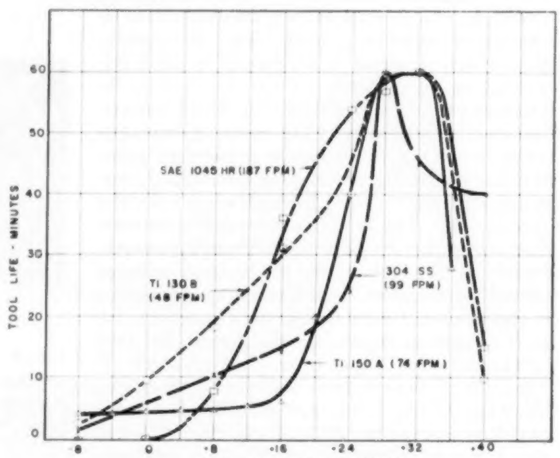


FIG. 11 EFFECT OF SIDE-RAKE ANGLE ON TOOL LIFE IN TURNING FOR FOUR MATERIALS

(Tool material: 18-4-1 HSS. Tool shape: 0—variable-6-6-6-15-0.010 in. Depth of cut: 0.050 in. Feed: 0.006 ipr. Cutting fluid, dry.)

Table 5 contains the Brinell hardness numbers and the Meyer strain-hardening exponents for the same materials included in Table 4. The Meyer exponents were obtained with loads varying from 1000 to 3000 kg in 500-kg increments.

### TOOL-LIFE PROPERTIES

Eventually, most metal-cutting studies lead to tool-life tests since it is this property which has the greatest commercial significance. A great many tool-life tests in turning have been run to evaluate the effect of side-rake angle. The results obtained to date are summarized in Fig. 11. The curves of tool life versus rake angle show the existence of a fairly sharp optimum for each of the four metals. It should be noted that

(*Continued on page 480*)

# ELECTROMAGNETIC PUMPS *for* *High-Temperature* LIQUID METAL


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## INTRODUCTION

IN the development of means of converting atomic power into a more controllable and conventionally usable form, a large effort has been devoted to the development of liquid metals as heat-transfer media. Because of certain requirements of liquid-metal systems, the development has included the investigation of a number of unusual means of pumping. One such means—the electromagnetic pump—has proved to be uniquely suited to the circulation of certain of the liquid metals. Its success in this field may help open the door to a more widespread use of liquid metals as heat-transfer fluids, and is therefore of general interest. The pumps themselves are of interest as unusual pieces of equipment, having no seals or stuffing boxes, and (at least in theory) no moving parts other than the fluid itself.

The particular requirements which caused the electromagnetic pump to be studied are as follows: (*a*) It is required that pumps, to be usable in any radioactive liquid-metal system, be leakless—to a degree higher than that capable of achievement with any known conventional shaft seal. (*b*) It is necessary that pumps have a high degree of dependability such as might be obtained with a device having no moving parts to wear out. In addition, sodium and its potassium alloys (commonly called NaK) have been widely considered as suitable reactor coolants, and their properties make them unusually amenable to pumping by electromagnetic means. A number of different types of electromagnetic pumps have been studied and built as a part of the work in the field of liquid metals, both to supply the requirements of various heat-transfer experiments using sodium and NaK, and to obtain design information on electromagnetic pumps for possible future application to nuclear power plants using sodium and NaK as heat-transfer fluids.

All of the electromagnetic pumps utilize the "motor" principle—that a conductor in a magnetic field, carrying a current which flows at right angles to the direction of the field, has a force exerted on it, the force being mutually perpendicular to both the field and the current. In all of the electromagnetic pumps the fluid is the conductor. This force, suitably directed in the fluid, manifests itself as a pressure if the fluid is suitably contained. The field and the current can be produced in a number of different ways and the force may be utilized variously. There are, therefore, a number of different types of electromagnetic pumps, all of them utilizing this principle. Numerous types are described in the following paragraphs.

## D-C FARADAY TYPE

The most elementary type of electromagnetic pump has been called the Faraday-type pump. In this type pump, the liquid metal is contained in a thin-walled duct, usually of square or rectangular cross section. A constant magnetic field is passed through the fluid on one axis perpendicular to the direction of flow. The field is developed by windings, d-c excited, arranged on a suitable magnetic core, which provides both pole faces and a magnetic return path. Current is forced through the fluid by impressing a voltage across the axis of the duct mutually perpendicular to both the field and the direction of flow. Usually "electrodes" are attached directly to the walls of the duct by brazing. These elements are shown diagrammatically in Fig. 1.

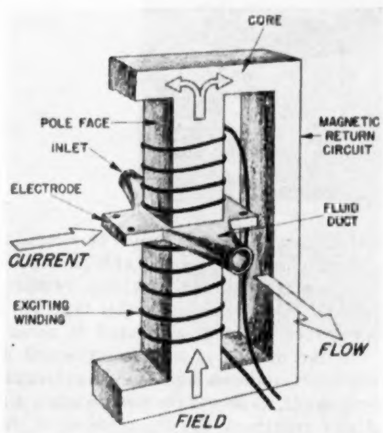


FIG. 1 D-C FARADAY TYPE—SCHEMATIC

In operation the pump is similar to the operation of a d-c shunt motor. The separately excited field magnetizes the gap. Flow of the current in the fluid in the gap is similar to current in a d-c motor armature. An $I^2R$ loss appears in the fluid. As the fluid flows a "back voltage" or emf is generated by the fluid moving in the field, being of such a direction as to oppose the flow of current in the fluid. The product of this back voltage and the effective current in the fluid represents the pumping power developed. Some current flows through the walls and creates a loss. In order to minimize this loss, the walls are kept as thin as possible, and are normally made of material with as high a resistivity as can be used. In the pumps built for sodium and NaK, stainless-steel type-347, or the equivalent, or Inconel, has been used without prohibitive losses. Current can by-pass the magnetic field by flowing down the duct, across, and back to the electrode. This also represents a loss, an effect which can be minimized in the design of the pump by having the magnetic field overlap the electrodes by an amount equal to two or three times the air-gap length.

Of all the electromagnetic pumps, this type is the simplest and inherently the most rugged and dependable. The main-

[1] Operated for the U. S. Atomic Energy Commission by the General Electric Company.


Contributed by the Hydraulic Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

taining of sufficiently cool electric windings is a problem common to all electromagnetic pumps; in this type pump it can be minimized by moving the exciting windings away from the hot-liquid duct and by insulating between the duct and the pole faces. Insulation between the duct and the pole faces requires more exciting current in the exciting windings and, consequently, a higher field loss, but this is not excessive.

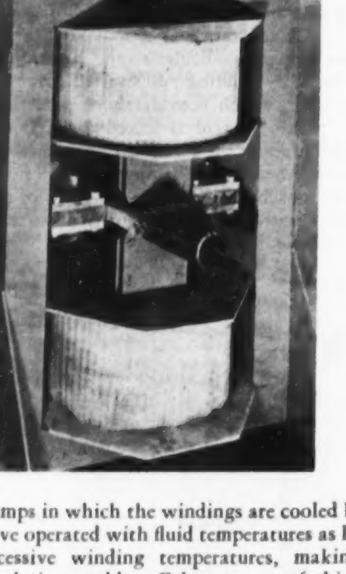

FIG. 2 100-GPM D-C FARADAY TYPE

Pumps in which the windings are cooled by natural convection have operated with fluid temperatures as high as 800 F without excessive winding temperatures, making varnish electrical insulation usable. Other pumps of this type use very low-voltage high-current windings connected in series with the "armature" in the manner of a series-connected d-c motor. In this arrangement, stainless steel is used as electrical insulation in the windings, as it is in the pump section or fluid duct.

Pumps of this type have the shortcoming of requiring an unusually high current supply. The pump section—the equivalent armature—is a single-turn armature, and at reasonable values of fluid velocities and flux densities can develop only relatively low back voltage. In addition, the armature is shunted both by the walls of the pump and the fluid at the extremities of the magnetic field—two paths of inherently low resistance. Consequently, this type pump is forced to operate at low voltages—in the neighborhood of 1 volt—and the current requirements are high. This characteristic has prevented the use of this type pump in applications where large fluid horsepower is required. In applications where the bulk and expense of high-current power supplies are not prohibitive, this type pump has found wide application and has proved to be simple and dependable.

Pumps of this type have been built for capacities as high as about 400 gpm and for heads as high as 100 ft. One design is shown in Fig. 2 and is representative of this type of pump. The unit shown there delivers 135 gpm against a head of 21 ft, weighs 950 lb, and requires 6000 amp at 1.25 volts.

### A-C FARADAY TYPE

It is immediately apparent that high currents can be obtained most readily from a transformer, and that a Faraday-type pump might be made to work on alternating current if the field were excited by alternating current properly phased with the voltage applied to the armature. A number of pumps of this type have been designed, built, and tested, and proved to have the advantage envisioned—that of requiring no bulky or special power supplies. Such pumps have, in general, the elements shown in Fig. 1 and possess the assets of being rugged, simple, and dependable. However, it has been found that pumps of this type contain additional losses which are quite large and their efficiency is appreciably less than that obtainable from d-c Faraday-type pumps. One of the major additional losses results from the fact that the fluid acts as a shorted turn in a transformer; the alternating field induces currents in the fluid which cause an $I^2R$ loss and increase the flux leakage around the gap. Pumps of this type have been developed which show efficiencies as high as 15 per cent.

One pump of this type is shown in Fig. 3. In this pump the current transformer which produces the high current has a magnetic core which is common with the core for the magnetic circuit of the pump, making a single unit. The pump is series-connected so that the flux in the gap and the current in the fluid

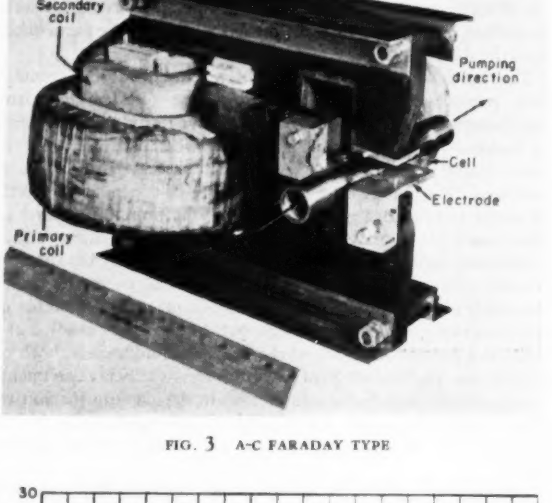


FIG. 3 A-C FARADAY TYPE

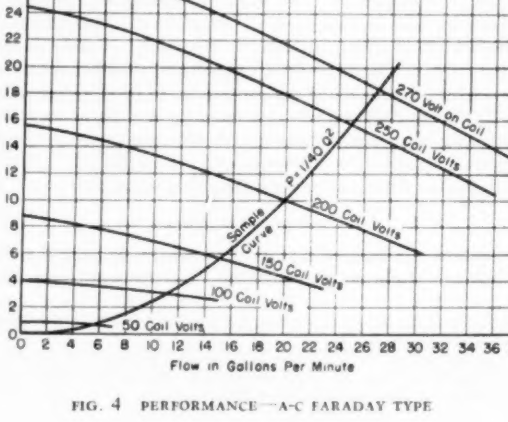


FIG. 4 PERFORMANCE—A-C FARADAY TYPE

are substantially in time phase. Typical performance curves for the pump are shown in Fig. 4.

Because of the low efficiency and the bulky magnetic circuit, pumps of this type have been limited to small sizes. Free convection cooling of the primary windings is not difficult, no special power source is required, and therefore small pumps of this type have been used generally for laboratory purposes where efficiency is less of a consideration than convenience.

### HELICAL-FLOW INDUCTION TYPE

This type of electromagnetic pump resembles an induction motor in principle and in operating characteristics. The fluid is contained in a duct formed in the annulus between two concentric cylinders, through which a thin helical vane is wound, dividing the annular duct into a number of parallel helical passages. The open ends of the helical passages connect to volutelike headers, joining the passages, and thence to the inlet and outlet openings of the pump; the fluid enters the pump, is distributed around the annulus, flows through the annulus with a helical motion, rejoins at the discharge header, and flows out into the discharge opening. Arranged around the periphery of the outer cylinder is a three-phase multipole winding which, both in appearance and design, is similar to the stator of a three-phase induction motor. Inside the inner cylinder are stacked iron laminations similar to those used in the rotor of an induction motor but containing no windings. As this inner core is not required to rotate, the core is held on a spindle which is restrained from rotation. The net effect is that of an induction motor in which the rotor conductors have moved into the air gap, have become a fluid enclosed in a thin hollow cylinder, and are separated into multiple helical paths. These elements are shown schematically in Fig. 5.

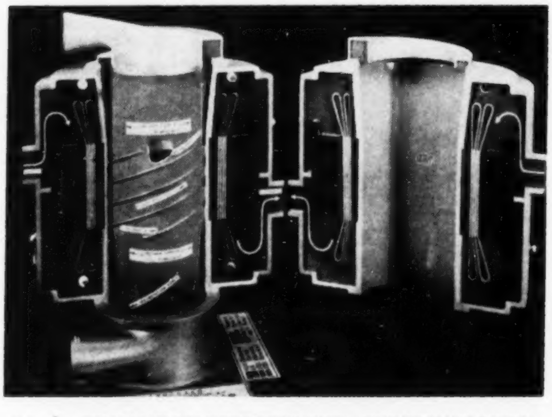

FIG. 5 HELICAL-FLOW INDUCTION TYPE—ELEMENTARY MODEL

The action of the three-phase winding is to create a rotating multipole field. This field, by inducing voltages in the fluid, causes a pattern of currents to flow in the fluid similar to those which flow in the rotor of an induction motor. The interaction between the field and the currents which are induced in the fluid produces a force which causes the fluid to tend to rotate. This force, exerted on all fluid under the poles, is resolved from a radial direction into an axial component by the helical vane so that a pressure rise is developed between the two ends of the cylinder. Copper rings are brazed to the inside wall of the duct at its two ends to provide a return path for the current, which flows axially in one direction under one pole and axially in the opposite direction under the adjacent pole.

In actual construction the inner and outer walls of the duct are usually parts of separate assemblies, the outer wall being a "liner" for the stator and its supporting structure, and the inner wall being a jacket for the inner magnetic core and its supports. As these walls are the source of losses due to induced currents in them, they are made as thin as possible and supported structurally by the stator core and inner magnetic core. As this arrangement results in the hot duct and the electric windings coming in close proximity, the stator liner is coated with a thermal insulating material, such as asbestos, to minimize the heat transfer to the stator iron. While at first glance this appears difficult, it has been found practical to maintain insulation temperatures at conservative values by circulating reasonable quantities of air through the windings, although they are located less than 1 in. from the hot duct.

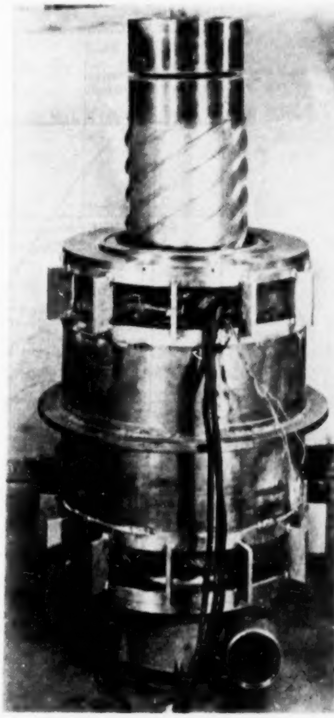

FIG. 6 HELICAL-FLOW INDUCTION TYPE—PARTIAL ASSEMBLY OF 400-GPM UNIT

The performance of the helical-flow induction pump is comparable in many respects to that of an induction motor with a high air gap and a high-resistance rotor. At a flow at which the fluid is rotating at the same speed as the field, the pump theoretically develops no pressure; this point corresponds to synchronous speed in an induction motor. Actually, because of internal hydraulic losses, this point is reached at a flow somewhat less than synchronous flow. The "slip" of the fluid with respect to the field is similar to the familiar slip of an induction motor. The entire performance of the pump is a function of the slip and the impressed voltage, the pressure rising as the slip increases. As in other types of electromagnetic pumps, the duct walls act as shunt current paths, and appear in this type pump as an equivalent high core loss—or as a high-resistance stalled rotor electrically in parallel with the fluid rotor. One loss finds no parallel in the induction motor; the fluid, flowing axially in the gap, has induced in it a circumferential voltage gradient. This causes currents to circulate in the zone where the fluid enters and leaves the field.

A number of pumps of this type have been built with moder-

ate success. This type of pump has its best application where relatively high pressures and low flows are required, and where size is at a premium. The high-pressure characteristic can be obtained by having a flat helix in the fluid channel so that, in effect, the fluid must pass over and be acted on by each pole a number of times as it flows through the pump. Pumps of this type have been built which develop heads as high as 260 ft of sodium.

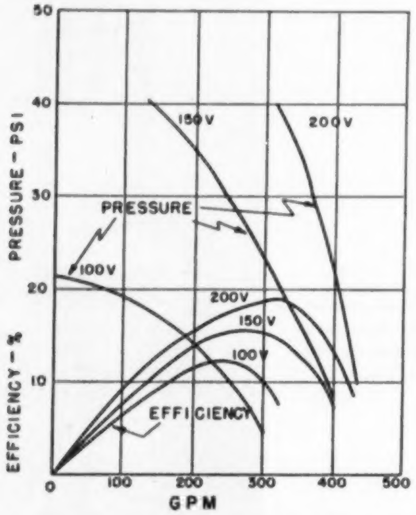


FIG. 7 PERFORMANCE OF HELICAL-FLOW INDUCTION PUMP
(Fluid, sodium at 750 F; frequency, 25 cps.)

A typical design is that shown partially disassembled in Fig. 6. This photograph, taken during the process of assembly, shows the "rotor" being lowered into place. The helical guide vanes can be seen wound around the inner liner. A volute and nozzle casting, similar to the one on the bottom, is to be welded to the top, completing the fluid circuit. The windings can be seen through the air slots. An outer cylindrical jacket containing cooling-air connections completes the pump assembly. This unit weighed 1500 lb, required 1000 cfm of air for cooling, and delivered 400 gpm of sodium against a developed head of 60 ft. The unit required 25 cps power, and operated at a power factor of 80 per cent. Typical performance curves are given in Fig. 7.

#### LINEAR INDUCTION PUMP

A fourth type which has been the subject of some development is the linear induction type. In operating principle it is identical to the helical-flow induction pump; however, its elements are arranged in a different form. The fluid is contained in a duct of rectangular cross section, connected at each end through transition sections to the inlet and discharge nozzles. In practice the aspect ratio of the duct cross section is of the order of magnitude of 25. A polyphase multipole a-c winding is located on both sides of the duct, with the axes of the coils perpendicular to both the large dimension of the duct cross section and the direction of flow. The winding is, of course, contained in a suitable iron core and properly supported mechanically. Thermal insulation is interposed between the duct and the magnetic core to minimize heat loss from the fluid and to make it possible to maintain a reasonable winding temperature. An expansion joint is provided to allow for the temperature differential existing between the hot duct and the relatively cold outer walls of the pump. Most of these elements are shown in the view of the model, Fig. 8. This shows a section "cut" through the model in the middle and typical construction. The fluid channel is the rectangular opening in the middle; it is divided into eight smaller channels by vanes which are only to provide stiffness to the duct walls. Cooling-air openings are on opposite sides of the outer walls of the pump. The three ribs visible in Fig. 8 are to provide stiffness to the plate supporting the magnetic core.

When a three-phase alternating voltage is applied to the windings a multipole field is established with adjacent poles of alternate polarity. This field moves down the duct, moving one pole pitch every half cycle. This moving field induces currents in the fluid which tend to make the fluid follow the field. The behavior is similar to that which occurs in the helical-flow induction pump. However, because the field is moving in the same direction as the fluid is required to flow, no guide vanes are required and the force which the moving field exerts on the fluid, divided by the cross-section area of the duct, is the pressure developed by the pump. The same relation between flow, synchronous flow, impressed voltage, and pressure exist in this pump as exist in the helical-flow pump; however, the type of end loss noted in the helical-flow pump has no equivalent in the linear induction pump. It is interesting to note that in all analyses of the various pumps the fluid in the gap has been treated as if it moved as a solid without appreciable error, that is, velocity profiles and random velocities have been neglected. While the calculation of performance is not entirely precise, there appears to be no indication that the assumption that the fluid moves as a solid body causes any appreciable error.

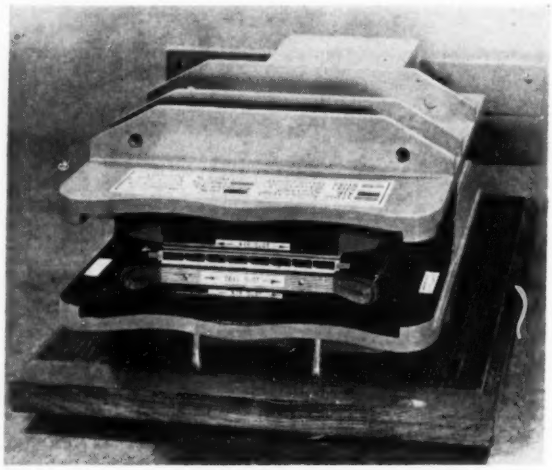

FIG. 8 LINEAR INDUCTION PUMP—ELEMENTARY MODEL

This type of pump is best-suited where relatively large flows at moderate heads are required and where space and power supplies are at a premium. Using standard electrical insulation, pumps of this type require forced-convection cooling systems of reasonable size. As in the case of the helical-flow induction pump, the windings are cooled by the forced circulation of air through suitably designed passages in the stator iron.

A pump of this type is shown partially disassembled in Fig. 9. In the unit as shown, the upper half of the winding has been removed, exposing the wall of the fluid duct. The end turns of the lower half of the winding are visible on the right. The light-colored strips are asbestos thermal insulation. The rec-

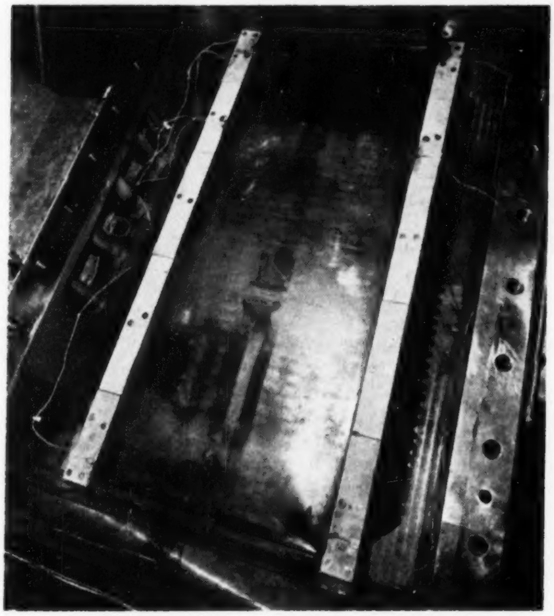

FIG. 9 LINEAR INDUCTION PUMP—PARTIAL ASSEMBLY OF 1200-GPM UNIT

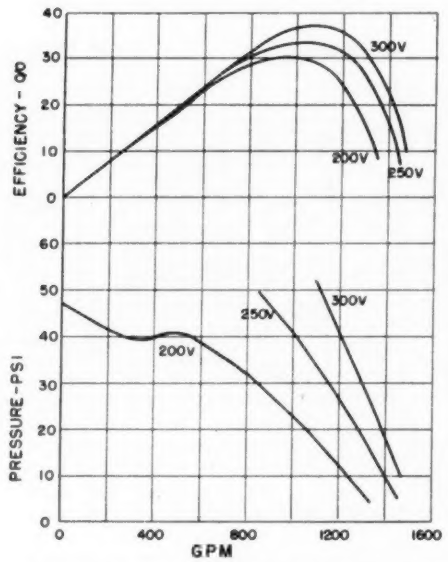


FIG. 10 PERFORMANCE OF LINEAR INDUCTION PUMP
(Fluid, sodium at 700 F; frequency 60 cps.)

tangular cooling-air opening is visible on the left. The small wires are the inevitable thermocouples. This unit delivered 1200 gpm at 850 F sodium at 110 ft developed head, at 300 volts, 288 amp, 0.45 power factor, 60 cps. The unit weighed 6430 lb and required 2000 cfm of cooling air. Typical performance curves for this unit are shown in Fig. 10.

GENERAL

By comparison to standard centrifugal pumps for conventional usage the electromagnetic pumps suffer in efficiency and size. However, the convenience or, in some cases, the necessity of having completely leakless operation has warranted their development and use. The units described are some of the types which have been investigated to fill certain specific laboratory and power-plant requirements.

The development of electromagnetic pumps has been rapid; the pumps have advanced in a few years from an engineering curiosity to a point where they are usable pieces of equipment and amenable to design in a straightforward manner. It is reasonable to expect that future development will lead to more improved designs, and that the pumping problem will be removed as a deterrent to more widespread use of liquid metals.

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# Tolerances and Specifications for Precision Investment Castings

(*Continued from page 457*)

The more stringent the inspection, the lower the recovery of acceptable castings and the higher the cost per piece. Some designers are still under the impression that because a part is to be precision-cast, it automatically should be free from pits, checks, and other surface defects in addition to being internally sound. For some small parts, these conditions can be controlled accurately. However, the larger the part, the greater the chance for surface defects and some internal shrinkage. This is particularly true for large flat areas.

Specifications on surface conditions should indicate which surfaces are to be free from pits and which surfaces should not be gated. The extent of permissible surface defects, that is, how many pits per square inch are allowed or how deep a pit is acceptable, should be specified wherever possible. Likewise, the degree of soundness required should be outlined clearly, since sometimes sound metal is absolutely required only in specific areas. Care in writing specifications of this sort is beneficial to the designer, as his requirements will be satisfied at an attractive price.

At the present time there are a large variety of steels and alloys available in the form of precision castings. As a result, most requirements for physical and mechanical properties, such as hardness and tensile strength, can be satisfied. When specifying these properties, it is desirable to allow a spread of six Rockwell points for hardness and a spread of approximately 25,000 psi for tensile strength. The one property of prime importance should be specified, rather than both. This is because the correlation between hardness and tensile strength of precision-cast metals is not the same as for other forms of the same materials. Inspection procedures such as zyglo and hydrostatic tests are available where required. If requested, certification of chemical and physical properties can be furnished.

CONCLUSION

Many of the commercial limitations of the precision-casting process are the same as those of other casting methods. In addition, many of the problems of conventional fabricating methods have been overcome by the new method. In fact, there are hundreds of parts that can be produced economically in quantity only by precision-casting. Therefore, whenever a casting of intricate shape and contour is required, whenever a part must be made from a material that is difficult to machine or forge, and whenever the casting must be held to close dimensions, the designer always should investigate precision investment casting.

# *Liquid-Metal Heat-Transfer System for Nuclear Power Plants*

## A Report on the Development of Suitable Heat Exchangers and Steam Generators


By THOMAS TROCKI[1] and D. B. NELSON[2]

KNOLLS ATOMIC POWER LABORATORY,[3] SCHENECTADY, N. Y.


### INTRODUCTION

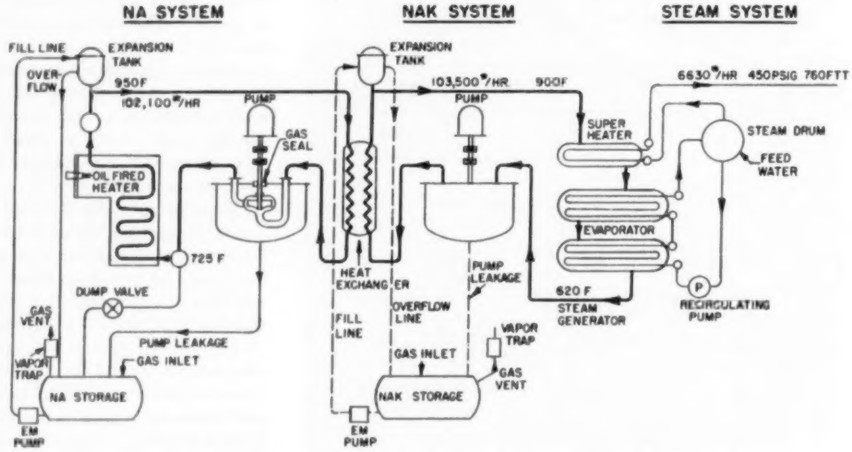
An important aspect of the general problem of converting atomic energy to useful power is the development of a heat-transfer system which will remove heat from a nuclear reactor and use it to produce steam suitable for power production. Water is currently used to remove waste heat from operating reactors at low temperature. To produce power, it is necessary to increase the average temperature of the reactor cooling system. Since there are restrictions against boiling in the reactor, a heat-transfer agent which remains liquid is required. Water can be maintained in the liquid state at high temperature by pressurization, but this introduces design difficulties attendant on a high-pressure system.

The high boiling point, stability at high temperature, and good heat-transfer characteristics of liquid metals make them attractive as heat-transfer liquids for reactor cooling. Low-melting-point metals and alloys like lead, lead-bismuth, sodium, potassium, and sodium-potassium have been considered for various applications. Sodium and sodium-potassium alloy were selected for development at the Knolls Atomic Power Laboratory. These metals have low melting points, high boiling points, are stable thermally, and have suitable nuclear and heat-transfer characteristics. Being slightly lighter than water and of similar viscosity, they require comparable power for pumping. The comparatively low specific heat of these metals ($^1/_4$ to $^1/_3$ that of water) is probably their most significant shortcoming. This requires weight flows of metal larger than water to remove the same quantity of heat with the same temperature difference.

Development work was started by the General Electric Company on systems using these metals in 1947, under a contract (Genie Project) with the U. S. Navy, Bureau of Ships, whose personnel made important technical contributions to the project. The Project was later moved to the Knolls Atomic Power Laboratory. To demonstrate the practicability of using sodium and sodium-potassium for power-plant-scale heat transfer and steam generation, a test system of considerable size and rating was designed, constructed, and has been operated for nearly 3 years at the Alplaus Site of the Knolls Atomic Power Laboratory.

### DESCRIPTION OF TEST SYSTEM

The test liquid-metal-heat transfer system is shown schematically in Fig. 1. It consists of two liquid-metal circuits in series, the first being a sodium circuit heated with an oil-fired heater.




1 SCHEMATIC DIAGRAM OF ALPLAUS HEAT-TRANSFER SYSTEM

The heat is then transferred through a heat exchanger to sodium-potassium alloy in the secondary circuit. The sodium-potassium alloy is then used as the heating medium in a steam generator. For this test the steam was condensed and weighed for heat-balance determination.

The test system was designed for an output of 6600 lb per hr of steam at 435 psig and 760 F. The rated temperature of sodium leaving the heater is 950 F, and the rated liquid-metal flows are in the order of 230 gpm (100,000 lb per hr). This plant rating resulted in 4-in-diam piping, which was considered of sufficient size to approximate power-plant practice in design and construction. A partial view of the test plant is shown in Fig. 2.

[1] Head, Heat Transfer Systems Unit, Engineering and Production Section. Jun. ASME.

[2] Power Plant Unit, Engineering and Production Section. Jun. ASME.

[3] Operated by the General Electric Company for the Atomic Energy Commission.


Contributed by the Heat Transfer Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

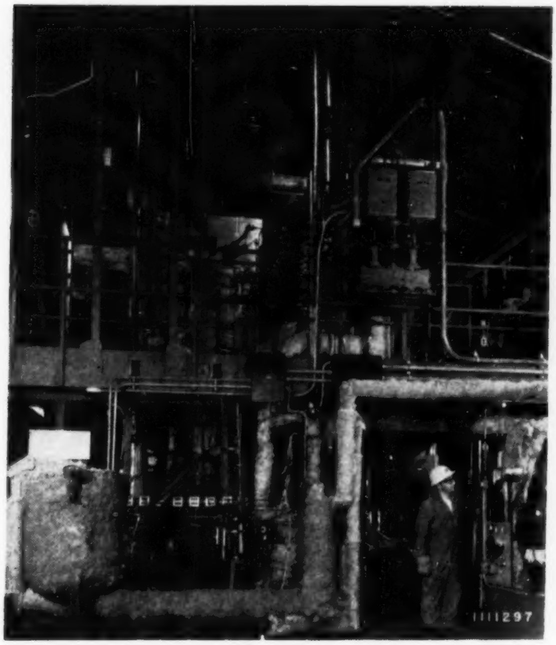



FIG. 2 PARTIAL VIEW OF ALPLAUS HEAT-TRANSFER SYSTEM

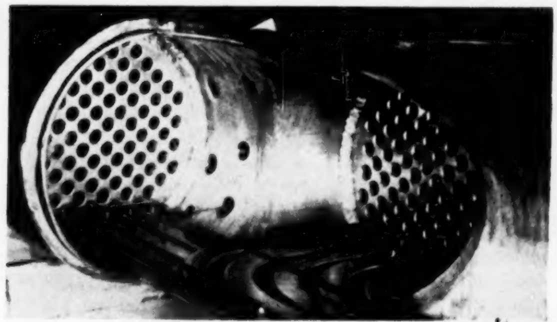


FIG. 4 SODIUM TO SODIUM-POTASSIUM HEAT EXCHANGER—FLAT TUBES

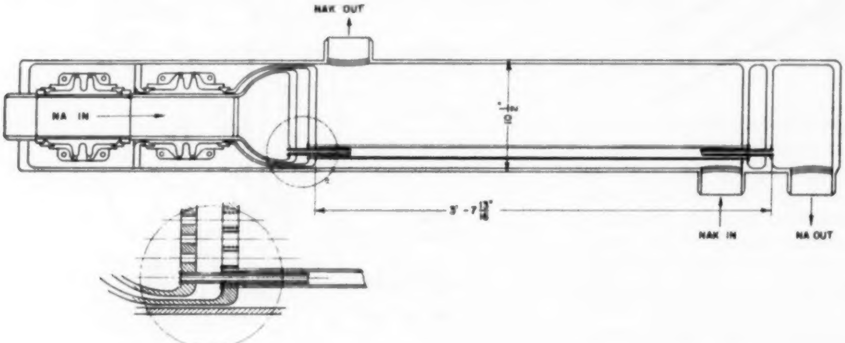



FIG. 3 SODIUM TO SODIUM-POTASSIUM HEAT EXCHANGER—CONCENTRIC TUBES

The test system actually contains two sodium-to-sodium-potassium heat exchangers of different designs and two steam generators, one using forced circulation of water and the other natural circulation. The units are piped so that either heat exchanger can be operated in series with either steam generator. Only a single heat exchanger-steam generator combination is tested at one time as the heater and pumps were designed for single-circuit heat load.

The "intermediate" liquid-metal heat exchangers are illustrated in Figs. 3 and 4. The main requirements for these units were: (1) "leak-proofness" between the fluids and to the atmosphere, and (2) minimum volume. The first requirement led to the selection of schemes for separating the fluids with two separate walls. The design shown in Fig. 3 is essentially a tube-and-shell heat exchanger modified to include concentric tubes and double tube sheets. Sodium fills the annulus between the tubes to provide a heat-transfer bond. It can be monitored for leakage of either fluid into the annulus. The design shown in Fig. 4 employs flattened tubes bent into hockey-stick shape and swaged round at the tube sheet. The primary and secondary fluids flow in separate sets of tubes, entering the straight end of the tube and leaving at the side of the exchanger. As before, the space between tubes is filled with static sodium. The bent-tube configuration eliminates the need for an expansion joint. In the concentric-tube design, the expansion joints were located within the outer shell to protect against leakage to atmosphere in event of failure of the bellows. Both units are of all-welded construction, the tubes being seal-welded at the tube sheets.

The requirement of minimum volume led to the selection of L-nickel as the tube material in both units. The high heat-transfer coefficients of liquid metals alters the distribution of heat-transfer resistance to the extent that the wall resistance becomes significant and may be predominant. For minimum heat-transfer area, it becomes desirable to minimize wall resistance by using thin-walled tubes of high-conductivity material.

The steam generators are shown in Figs. 5 and 6. The most significant feature of both units is their concentric tube construction. The protection of double walls was adopted in these units to avoid the potentially violent reaction between the sodium-potassium and water. In the steam generator, mercury is used in the annulus between tubes as it is nonreactive with water and provides an adequate thermal bond.

The main difference between the units is in the water circuits. The unit shown in Fig. 5 employs a natural recirculation, and the unit in Fig. 6 forced recirculation. There are two parallel water-steam circuits in the forced-circulation unit, each feeding into a separate drum. This arrangement was selected to evaluate the relative performance of individual circuits under conditions of nonuniform flow.

The main liquid-metal circulating pump[4] designed for this

[4] "Mechanical Pumps for High-Temperature Liquid Metal," by P. M. Clark, ASME Paper No. 52—A-94. To published in a later issue of MECHANICAL ENGINEERING.

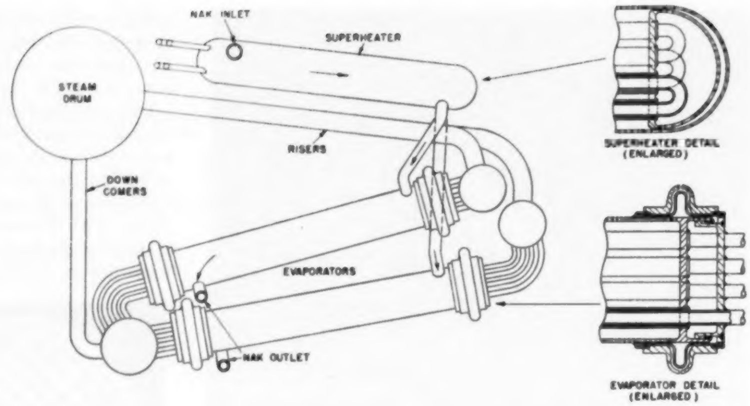



FIG. 5 NATURAL-CIRCULATION STEAM GENERATOR

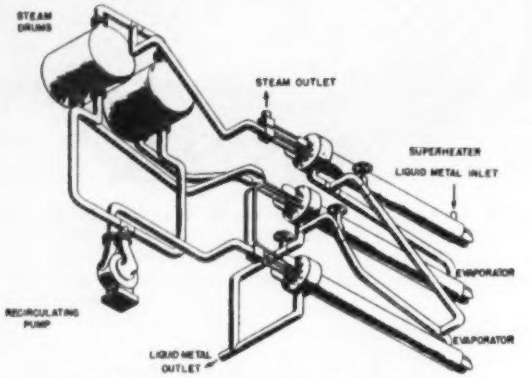



FIG. 6 FORCED-CIRCULATION STEAM GENERATOR

application is shown in Fig. 7. Its rating is 400 gpm, 126 ft head, at 1750 rpm. It is a centrifugal pump with an overhung impeller, the bearings being removed from close proximity of the hot liquid metal. The unusual feature of this pump is its method of shaft sealing. A labyrinth seal is provided at the pump casing, and the entire pump is enclosed in a tank which drains the leakage back into the sump tank. This leakage is made up by continuous operation of a small electromagnetic filling pump which is completely sealed. Liquid metals can be pumped by direct action of electromagnetic forces.[6]

The pump tank is filled with inert gas which is sealed at the shaft with a mechanical face-type seal. The lubrication of this seal was a considerable problem, as lubricating oil is an undesirable impurity in the liquid metal. A method was devised using very limited lubrication (1 drop per hr) and provision made for catching and draining off oil leakage. These pumps have given satisfactory service in this application with occasional seal replacement.

The system is thoroughly instrumented to determine over-all heat-transfer performance of the heat exchangers. In addition, provision is made to suspend metallurgical specimens of construction materials in both hot and cold zones of each liquid-metal system. Transport of wall material by differential solubility in the liquid metal was noted in the mercury circuit of binary-cycle power plants. The measured metallurgical specimens were installed to detect and measure this phenomenon

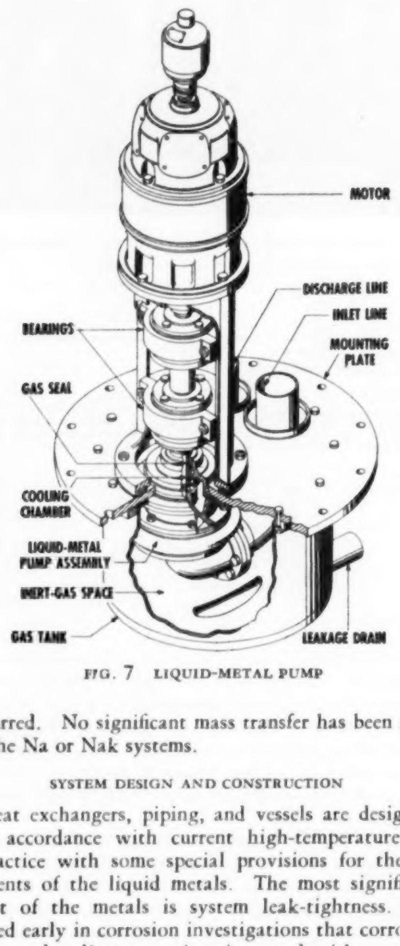



FIG. 7 LIQUID-METAL PUMP

if it occurred. No significant mass transfer has been noted to date in the Na or Nak systems.

### SYSTEM DESIGN AND CONSTRUCTION

The heat exchangers, piping, and vessels are designed and built in accordance with current high-temperature power-plant practice with some special provisions for the unique requirements of the liquid metals. The most significant requirement of the metals is system leak-tightness. It was determined early in corrosion investigations that corrosiveness of sodium and sodium-potassium increased with oxygen contamination. For this reason it is highly desirable to minimize leakage of air into the system.

Leak-tightness is important from another standpoint as well. As these metals will burn readily in air when hot and are hazardous to personnel, it is important to prevent leakage out of the system. In early handling experiments, it was noted that hot liquid metal would leak out of a system which had

[6] "Electromagnetic Pump for High-Temperature Liquid Metal," by J.F. Cage, Jr., ASME Paper No. 52—A-66.

been tested hydrostatically. The metals attack slag penetration through welds and work through the flaw. No leakage difficulty is encountered with sound welds.

For these reasons, considerable care was exercised in the design and construction of the test system to attain leak-tightness. The liquid-metal circuits are welded completely and contain no flanged joints. Flanges with metallic gaskets are used in the gas atmosphere only. Bellows-sealed valves are used with the bellows welded into the valve assembly. The precautions for pump-shaft sealing have been described earlier in this paper.

It also was indicated earlier that hydrostatic testing of systems and equipment has not proved completely satisfactory. One reason for this is that liquid-metal systems are usually designed for low-pressure operation (100 psig or less) and cannot be tested to a high pressure without endangering some of the system components like the bellows in the valves. As it appeared necessary to establish leak-tightness during fabrication of equipment and piping, it was decided to use the most sensitive vacuum leak-detection methods. All liquid-metal piping and equipment were leak-tested using the helium mass-spectrometer leak detector and all detectable leaks were repaired. Subsequent leak-tightness of the piping and equipment attested to the value of this precaution.

The liquid-metal piping circuits are constructed of type-347 stainless steel. This material was selected because it appeared superior in early corrosion investigations and is a high-temperature material with which considerable fabrication experience has been accumulated. Subsequent corrosion work has indicated that other stainless steels also are suitable. L-nickel is used in the heat-exchanger tubes.

Since no source of contamination can be overlooked, care was exercised during fabrication to minimize accumulation of extraneous materials in the equipment and piping. All components were degreased before shipment and the completed liquid-metal systems were degreased with dichlorethylene, then evacuated, and dried with application of heat.

Heating during drying is easily accomplished on a liquid-metal system since provision must be made to preheat the piping to a temperature above the melting point of the metal for filling and to maintain it molten in event of shutdown of the heat source. Both sodium and sodium-potassium systems were supplied with pipe heating systems although sodium-potassium is liquid at room temperature. Heating was installed on the sodium-potassium system to permit later substitution of sodium for the sodium-potassium if desired. Electrical resistance heating is used. Special heating wire is wound around all piping and equipment and is spaced to deliver approximately 100 watts per sq ft. The system is insulated with 3 in. of mineral wool with a wire-mesh backing. The mineral wool was determined to be nonreactive with sodium and sodium-potassium by test. A chemically reactive insulation might contribute to the fire in event of a leak, whereas a nonreactive one assists in smothering the fire.

After being evacuated and dried, the completed systems were filled with an inert atmosphere. Lamp-grade argon is used, although pure nitrogen and helium also are suitable. Argon was selected because it is available highly purified, at reasonable cost, and is heavier than air. The latter property permits removal of flange covers from tanks with minimum rate of air infiltration.

During normal operation, the system gas pressure is adjusted to hold slightly above atmospheric pressure to minimize leakage through the pump seals, which is usually less than 0.1 cfh. A gas vent is provided at the sump tank to maintain a fixed pressure as system temperatures are increased.

### LIQUID-METAL PURIFICATION

The charges of sodium and sodium-potassium for this system were purified by distillation. It has since been determined that adequate purity can be obtained by filtration at low temperature; however, at the time there was some question of the adequacy of filtration. The oxygen content of the charges was determined by sampling and analysis to be less than 200 ppm of oxygen. When charged into the sump tanks, the surfaces of the metals were observed to be clean and shiny. Owing to the high degree of chemical activity of sodium, any impurities in the blanket gas soon appear as cloudy film patches on the free surface. After circulation through the system, such patches were observed and have persisted without any harmful effects.

### OPERATING EXPERIENCE

The sodium-potassium system was filled and circulated first (December, 1949) because more trouble-free experience had been accumulated previously with this liquid metal in small laboratory systems. After establishing satisfactory circulating performance with the sodium-potassium, the sodium system was filled in February, 1950. The first steam was generated in April, 1950, followed by several months more of shakedown operation to establish a satisfactory heat balance as some difficulty was encountered with instrumentation. The plant was then devoted to the accumulation of heat-transfer data and has been operating primarily for this purpose to date.

The measured performance of the complete plant agrees quite closely with predicted performance at the design point. At reduced loads, however, the heat transfer through both heat exchangers is considerably lower than predicted. Detailed heat-transfer performance results are reported in a separate paper.[6]

The plant has been operated on a three-shift basis during the work week and kept in stand-by over the week ends. Many thousand hours of liquid-metal circulation and steam generation have been accumulated on this schedule without any serious difficulty. Maintenance shutdowns chargeable to the liquid-metal systems have been due to occasional gas-seal replacement in the main liquid-metal circulating pumps, replacement of several valves as a result of bellows failures, and replacement of electromagnetic filler pumps. One leak was observed in a remote field weld (2-in. IPS) when a slag inclusion was dissolved after 1200 hr of exposure to sodium-potassium.

Repairs to the liquid-metal systems are made with the metals drained to their storage tanks. Contamination of the metals with air has been avoided by providing flow of inert gas out of pipe cuts and drilled holes. Replacing valves in the circulating system required cutting the main 4-in. piping. To minimize the loss of gas and chances of contamination during the repair, rubber balloons were inserted into the pipe on the system sides of the repair. Inflated with inert gas, the balloons are effective seals for low-pressure gas. The new section of piping, including the valve, is purged liberally with inert gas prior to being opened into the main system.

Occasional repairs and continual leakage of gas through the pump seals lead to some contamination of the liquid metals with oxygen and water vapor. The sodium has been recleaned periodically by low-temperature by-pass purification. The purification method is based upon the fact that the solubility of oxygen in sodium decreases with decreasing temperature. The system is maintained at 700 F, or above, and a small per-

[6] "Nuclear Power Plants—Design and Performance of Liquid-Metal Heat Exchangers and Steam Generators," by R. D. Brooks and A. L. Rosenblatt. Mechanical Engineering, May, 1953, pp. 363–368.

centage of flow is by-passed to a "cold trap" where the sodium is cooled to just above the melting point and the precipitated oxide removed by filtration. Satisfactory purification is accomplished in one or two system turnovers.

The sodium potassium has been reprocessed in like manner though analysis indicates that the oxygen content has not increased beyond an acceptable limit. It is suspected that the oxygen is accumulating in cold zones throughout the system such as drain lines, instrument taps, and other auxiliary connections. No difficulty has been encountered, however, from this source. Corrosion specimens suspended in both hot and cold legs of the circulating systems showed no significant corrosion or mass transfer. After several thousand hours of operation a superheater was removed from one of the steam generators. Detailed examination of tube surfaces showed no corrosion by the sodium-potassium or the mercury in the annulus between the tubes.

### FIRE CONTROL

The alkali metals burn spontaneously at all operating temperatures; therefore provision for fire control is important. Selection of a nonreactive thermal insulation is important because the insulation will smother a leak permitting its detection with telltale smoke before the metal can burn vigorously. Quick remedial action is required in event of large leaks because the burning metals produce large quantities of a very dense and irritating white smoke which makes visibility poor and fire fighting difficult.

Dry powders are used to smother fires of alkali metal. Soda ash is effective, and a special powder is available which can be sprayed from a nitrogen-pressurized dispenser. Protective clothing was developed at the Knolls Atomic Power Laboratory which can withstand direct splashes of high-temperature alkali metals without burning the wearer.

The best fire protection, however, has been an alert and well-trained crew of volunteer firemen among the operating crew who, by quick action, brought under control the several fires encountered due to spills of liquid metal.

### CONCLUSIONS

1 Through almost 3 years of test operation of a sodium to sodium-potassium to steam heat-transfer system of pilot-plant scale, it has been demonstrated that a system of this type is feasible for steam generation. The test system was designed and constructed using industrial-plant procedures and operated in a manner similar to a central-station power plant.

2 The measured heat-transfer performance of the plant agreed with predicted performance within a few per cent at the design point. Measured performance at part load was considerably lower than predicted.

3 No significant corrosion of the structural and tube materials has been noted. Examination of special corrosion specimens and samples of the system components show no attack.

4 Repairs and replacements have been made to the liquid-metal circuits using field methods without serious contamination of the charges.

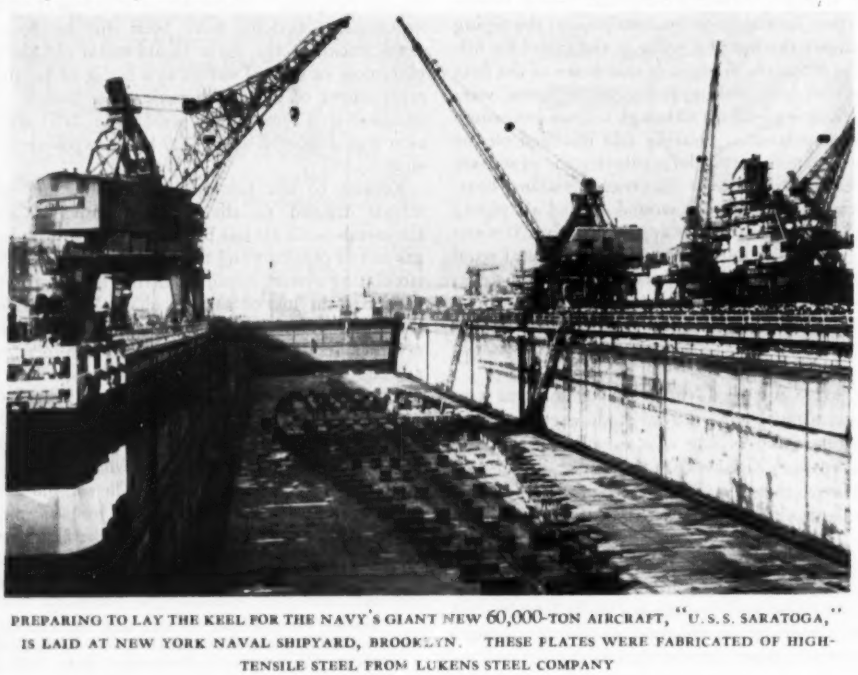
5 A satisfactory method of periodic repurification of the sodium has been demonstrated.


### ACKNOWLEDGMENTS

The authors wish to acknowledge this opportunity to represent the combined contributions of the many people of the General Electric Company who participated in this development.

The detail piping and structural engineering for the test system was done by the Construction Engineering Division of the General Electric Company under the supervision of Mr. L. R. Biggs, Manager.

Test heat exchangers and steam generators were manufactured by The Babcock & Wilcox Company, Combustion Engineering-Superheater, Inc., and Foster Wheeler Corporation, to designs selected after co-operative studies with representatives of these organizations. The main circulating pumps were designed in co-operation with Buffalo Pumps, Inc., and supplied by them. Gibbs & Cox, Inc. represented the General Electric Company as design agent on this project.

PREPARING TO LAY THE KEEL FOR THE NAVY'S GIANT NEW 60,000-TON AIRCRAFT, "U.S.S. SARATOGA," IS LAID AT NEW YORK NAVAL SHIPYARD, BROOKLYN. THESE PLATES WERE FABRICATED OF HIGH-TENSILE STEEL FROM LUKENS STEEL COMPANY

# *Selected* PLASTICS *References for the* MECHANICAL ENGINEER 1951–1952

By A. K. SCHMIEDER and H. G. DIKEMAN

MONSANTO CHEMICAL COMPANY, PLASTICS DIVISION, SPRINGFIELD, MASS.

THIS brief review is designed to draw attention to those currently reported developments in the plastics industry which are judged to be of interest to mechanical engineers. The Bibliography includes recent specific developments and reviews which serve as a guide to a restricted field and its literature. The term developments is used to include new application trends and extensions of information as well as innovations and inventions.

#### MATERIALS

Extended applications rather than development of basically new plastics continue to predominate in published literature (1).[1] In striving for plastics useful over a wider range of temperature, the ethoxyline, silicone, and fluorocarbon types (2, 3, 4, 5, 6, 7) continue to find wider use. Polymers in latex and suspension form are growing rapidly in importance. An excellent review (8) summarizes all the available types, their properties and uses. A relative newcomer, polyamide suspensoid, appears valuable in sealing, coating, and sizing applications (9, 10). The properties of improved styrene copolymers have been compared to the older types (11). Unplasticized polyvinyl chloride and rigid copolymer compositions are receiving more attention and wider application (12, 13, 14). Plastisols with a gelling agent are capable of retaining detail during curing after molding (15).

#### PROPERTIES

Use of a new versatile tester has confirmed that ozone is the only agent which alone produces weathering of rubberlike materials (16). An explanation of the molecular mechanism of weathering and its effects on mechanical properties has been presented (17). The dimensional changes and other effects of absorbed water and heat or cold are reported for several materials (18, 19, 20, 21). The improvement of dimensional stability of polystyrene by annealing (22) and of its strength by hot elongation (23) have been demonstrated. Additional gas-permeability data on several materials are now available (21, 24). One of these investigations (24) indicates that the permeability "constant" is actually a linear function of the vapor pressure in some cases. Contrary to published claims, polyethylene pipe has been found to impart sufficient taste to place some limitations on its use for drinking water (25). Use of plastic tubing for natural-gas service for the past 7 years indicates it to be competitive with other tubing for new installations and to have a cost advantage for replacement work (26). Knowledge of the dielectric and other properties of plastic insulators has been expanded to include more materials and a wide frequency range (27, 28, 29, 30).

A comprehensive study has been made of the creep properties of acrylic resins under various loadings and a correlating theory developed (31). The continued study of low-temperature effects has resulted in a paper on the change in general properties and its design significance (32), and another reporting increased impact strength with decreasing temperature (33). A summary has been made of previously published information regarding the mechanical properties of many laminates under various conditions of temperature, aging and immersion (34) and under various directions of loading (35).

Progress has been made in increasing the significance of tests to determine the mechanical properties of plastics (36). The increasingly important dynamic testing technique has been clarified further by experimental and theoretical studies (37, 38, 39). Four testing machines used to evaluate film properties of importance to packaging applications have been described (40). The results of tests by these machines have been correlated with shipping experiment results to evaluate the predictive validity of each type of test (41). Several investigators have reported influence of velocity and specimen size on impact-test results (42, 43). Successful evaluation of the cracking sensitivity of polyethylene polymers by using scratched and pipe specimens, creep-tested, has been reported (44). The technique of measuring residual stress by progressive material removal has been applied effectively to plastics (45).

#### FABRICATION TECHNIQUES

Use of lead-loaded materials to study flow lines and a hot spot to eliminate curing time are among the topics discussed in a general paper on transfer molding (46). Injection-molding of sections thicker than $^1/_8$ in. has been discussed from the viewpoint of common defects, their cause and elimination (47). The continued emphasis on increased capacity of injection-molding machines is reflected by the current literature which includes description of a 300-oz machine (48), the use of a screw pr plasticizer (49), a listing of the products and users of large machines (50), and statistics on the size and number of machines sold (51).

Again during the past year, the problems connected with extrusion have stimulated many investigations. These include basic theoretical analyses of the screw (52, 53) and die (54) actions. Among the descriptive papers are those dealing with such specialized problems as the extrusion of polyvinyl-chloride cable covering (55) and the minor machine modifications required for polystyrene extrusion (56) and nylon injection (57). Study of the film-extrusion process also continues (58, 59).

Among the more limited production problems studied, we find

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

heating of materials (60, 61), metal-plating of plastics (62, 63), dry coloring (64), drilling (65), blow-molding of bottles (66), conveying through pipes (67), electroventing (68), forming (69, 70), and continuous measurement of film thickness without contact (71). Pronounced effects of humidity during fabrication on the physical properties of glass-fabric laminates were reported (72). A paper has been published which assesses the various air pressure-forming methods and gives examples of statistical analysis used in the study of processing difficulties (73). The manufacture of decorative laminates with emphasis on surface finishing has been reviewed (74). The machining of articles from laminates has been described in detail (75, 76, 77).

Recent developments in the manufacture and use of synthetic fibers are found in two reviews (78, 79). Tests of several resin finishes applied to cotton fibers show crease resistance and anti-swelling to be about the same for different materials and to be decreased by long curing (80).

Literature on both the manufacture and the application of silicone rubber (81) and elastomers (82) has been reviewed and listed.

#### APPLICATIONS

The recent literature on application deals mainly with expansion in fields previously entered (83, 84) and general surveys to aid correlating requirements and available materials. The fields surveyed include industrial piping (85, 86), furniture (87), can-lining (88), and building construction and equipment (89).

Two general discussions of the organic materials available for coating metals are useful for orientation in this complex field (90, 91). Two reviews devoted to synthetic-latex paint indicate the interest in this recent development (92, 93). Details regarding the successful application of both silicone paint (94) and vinyl-resin coatings (95) to the protection of refinery equipment have been published. Additional experiments have furthered the evaluation of various fungicidal agents used in protective coatings (96). Detailed descriptions of the use of two resins for paper coating have been published (10, 97).

The large variety of potential uses of plastic adhesives is indicated by the numerous reviews each focused on a different type of application (98, 99, 100, 101, 102, 103). Results of specific applications reported include bonded brake linings (104, 105) and thermoplastic moldings (106). Knowledge useful in the application of plastics for bonding aircraft structures is provided by the fatigue tests reported (107). One investigator has made progress in clarifying the basic thickness-strength relationship for adhesive joints (108).

Conspicuously numerous are the references relating to the use of low-pressure laminates in making large structural parts for aircraft and automobiles (109, 110, 111, 112, 113, 114). Electrical-equipment manufacturers continue to develop the use of plastics for smaller more rugged electronic components (115), cable insulation (116, 117), and lighting shades and reflectors (118). A resistor tape particularly applicable to printed circuits has been developed and tested (119). Metalworking industries have found further uses for plastics production and design tools (120, 121). The interest of foundrymen in shell-molding continues unabated (122, 123) and has extended to plastic core driers (124). Specific materials whose use has been reviewed include foam plastics (125, 126), silicone rubbers (127), neoprene (128), and vinyl-film packaging materials (129). Polyvinyl chloride has been used for protective clothing (130) and conveyer belting (131). The successful use of nylon ball-bearing races for silent or corrosion-resisting applications is of interest (132).

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# Cutting Characteristics of Titanium and Its Alloys

(*Continued from page 466*)

only one size of cut was used and the tool shape was held constant except for the side-rake angles. This is not a complete picture but it does appear to indicate that optimum rake angles when cutting with high-speed-steel tools are larger than was expected. It is interesting to speculate whether there is any dependent relationship of this fact to the larger shear angles also peculiar to titanium. The cutting speeds represented in Fig. 11 are those which result in a tool life of 1 hr with the optimum rake angle. These speeds are summarized in Table 6.

TABLE 6 CUTTING SPEEDS FOR 1-HR TOOL LIFE AT OPTIMUM RAKE ANGLE

| Work material | $V_{60}$, fpm |
|---|---|
| RC 130B | 48 |
| Ti 150A | 74 |
| 304 SS | 99 |
| SAE 1045 | 187 |

SUMMARY

Titanium demonstrates cutting properties that are unique in the degree or magnitude of the property. Some of these are as follows: (1) It work-hardens more superficially than some other metals. (2) It has little or no tendency to form a built-up edge. (3) It forms very thin chips relative to the thickness of the cut and thus tends to intensify problems related to pressure and temperature. (4) Specific energy consumption is of the same magnitude as for medium-carbon and low-alloy steels.

A substantial field of plastic strain has been revealed ahead of the familiar shear zone. This holds forth many possibilities for further investigation and extension of metal-cutting theory.

There appears to be a good correlation between shear angle and tensile properties of metals including titanium. However, the correlation may be indirect since there is no obvious basis for such a dependency.

The probable higher temperatures and pressures are at least partially confirmed by relatively low cutting speeds for a constant tool life compared to SAE 1045 steel.

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# *Industry Points Way to*

# NUCLEAR POWER[1]

## *Four Reports on Technical and Economic Prospects*

FOUR different approaches to practicable nuclear-power plants of central-station size by four industry teams all conclude that power generation from fissionable fuel is possible within five years, that suitable reactors can be built and operated, that the steam-generating problems are unusual but not insuperable, and that the economic aspects are not yet bright. For more than two years these four groups have sifted all phases of reactor technology to determine, first, the feasibility of assembling a complete plant in the next four to six years and second, the capital and fuel costs that would be involved under private enterprise.

These task groups work under contract with AEC but meet their own costs: Dow Chemical Company-Detroit Edison Company, Commonwealth Edison Company-Public Service Company of Northern Illinois, Monsanto Chemical Company-Union Electric Company of Missouri, and Bechtel Corporation-Pacific Gas and Electric Company.

Each study group has examined one or more reactors for the production of heat convertible to steam power, some with associated plutonium production, some for power alone. Significantly, no two teams come up with the same reactor. In general, reactors for plutonium production are limited to a *fuel* temperature of 1000–1100 F and therefore to steam conditions in the 150–500 psi range at 750 F or lower temperature.

Simplest to describe is the Chicago group proposal for a helium-cooled graphite-moderated reactor contained in a 44-ft diameter steel shell under 10-atmospheres pressure, Fig. 1. Natural uranium metallic-fuel slugs are arranged in a lattice[2] with 840,000 cfm of pressurized helium blown through the lattice by twelve 2500-hp axial-flow blowers. Maximum internal metal temperature is limited to 1000 F to prevent transformation of uranium slugs to the beta phase. Helium flow of 3,270,000 lb per hr is raised from 450 to 742 F, then passed through twelve boilers which produce 906,000 lb per hr of 250 psi 525 F steam to generate a net output after auxiliaries of 46,700 kw.

An alternate Chicago group proposal comprises a heavy-water-cooled reactor in a 20-ft diameter cylindrical steel shell fueled by uranium elements in thin metal casings, Fig. 2. The heavy-water at an outlet temperature of about 420 F circulates through 18 steam generators to produce a total of 3,250,000 lb per hr of 180 psi saturated steam supplying 254,000 kw from three 80,000-kw units. After auxiliaries a net output of 211,500 kw is available.

The Monsanto-Union Electric report also proposes two plant possibilities, one for 220,000 kw and a larger arrangement ranging from 579,000 kw up to 878,000 kw. In both plants the reactor is a metallic-sodium cooled graphite-moderated octagonal prism 20 ft high and 35 ft across flats. A fuel charge of 2300 tons of enriched uranium can produce both plutonium and power with a sodium outlet temperature of 650 F for the smaller plant and 900 F for the larger. The sodium coolant avoids pressurizing the reactor and gives higher plutonium production rates for a given size (power) reactor. See Table 1.

TABLE 1 CHARACTERISTICS OF MONSANTO-UNION ELECTRIC SODIUM-COOLED GRAPHITE REACTOR DESIGNS

| Data | Case A | Case B |
|---|---|---|
| Purpose | Pu and power | Pu and power |
| Neutron energy | Thermal | Thermal |
| Power, heat, mw | 1000 | 3000 |
| Materials and amounts: | | |
| % enrichment of $U_{235}$ | 0.83 | 0.95 |
| Uranium, kg | 214,000 | 214,000 |
| Fuel elements | Int cooled | Int and ext cooled |
| Moderator | Graphite | Graphite |
| Reflector | Graphite | Graphite |
| Shield | Concrete | Concrete |
| Primary coolant | Na | Na |
| Fertile material | $U_{238}$ | $U_{238}$ |
| Max uranium temp, F | 1100 | 1100 |
| Coolant: | | |
| Inlet temp, F | 300 | 300 |
| Outlet temp, F | 650 | 900 |
| Max vel, ft/sec | 20 | 20 |
| Gal/min at 300 F | 70,000 | 120,000 |
| Cfm at 300 F | 9000 | 16,000 |
| Pumping power req (50% eff), kw | 3000 | 5000 |
| Dimensions: | | |
| Core, octagonal | 20 × 35 ft | 20 × 35 ft |
| Reflector thickness, ft | 2 | 2 |

Encased fuel elements, centered in cooling channels, can be loaded and unloaded with the reactor under full load. The whole charge of uranium can be slightly enriched or the reactor can be "spiked" with more highly enriched material in a few channels. The power cycle is based on receiving sodium from the reactor at 650 F and returning it at 300 F. Double-tube heat exchangers (to guard against sodium-water accident) can produce 3,000,000 lb per hr of 150 psi saturated steam and about 220,000 kw from two turbine units. Auxiliary power will use about 5.5 per cent of this.

Higher-temperature sodium, 900 F, can be produced if fuel elements are externally as well as internally cooled. If used to generate steam at 400 psi 746 F, the reactor heat output can supply 8,800,000 lb per hr to produce 878,000 kw from five turbine units with auxiliary power at about 5 per cent. A compromise variation proposes to reject heat from the coolant below 500 F to 300 F directly to a secondary cooling system by producing 25 psi steam to be condensed in a water-cooled heat exchanger. This nets 4,800,000 lb per hr of power steam and about 579,000 kw (554,000 kw net after auxiliaries) from three turbine units.

Detroit proposes an initial investigation of a sodium-cooled fast breeder reactor with solid-fuel elements of a uranium alloy. Outlet coolant temperature of 1022 F allows production of 135,000 kw from conventional steam plant. See Case B, Table 2.

The Pacific group reports that a light-water-cooled heavy

[1] A summary prepared by S. A. Tucker, ASME Publications Manager, member representing ASME, of AEC Advisory Committee on Industrial Information which aided in condensing and preparing these study reports for declassification. Full text is available from the Government Printing Office.

[2] See "Uranium, Plutonium, and Industry," published by ASME, 1952.

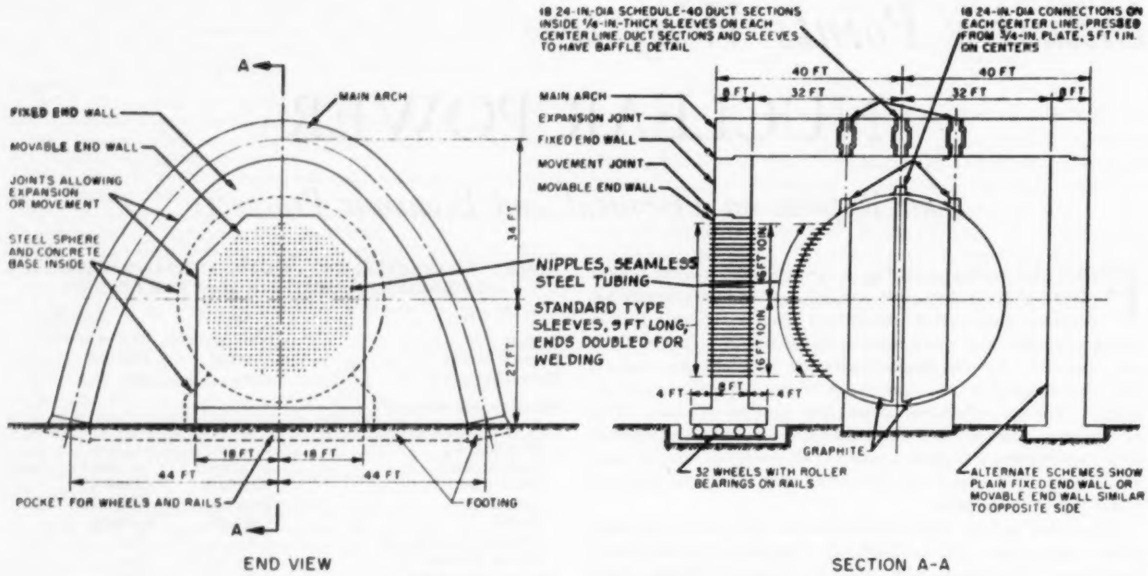



FIG. 1 PRESSURIZED-HELIUM-COOLED REACTOR PROPOSED BY CHICAGO GROUP

(One thousand tons of high-purity graphite form two cylinders 35 ft diam and 10 ft thick containing finned-fuel slugs of uranium metal, all inclosed in 44-ft-diam steel sphere and concrete radiation shield.)

water moderated reactor can be designed and built more quickly than other types but is limited to low steam pressures. However, a liquid-metal-cooled fast reactor has the ability to breed new fissionable material and to operate at high temperatures.

For the first type, Pacific proposes a reactor comprised in an aluminum tank 13.2 ft diameter and 11 ft high with a number of tubes between tube sheets serving as container for the moderating heavy water, Fig. 3. Sixty tons of natural uranium fuel is charged in pressure tubes extending through the core tank concentric to the aluminum tubes. Light water, the primary coolant, flows through these pressure tubes under 1000 psi pressure and is heated from 384 to 500 F. Conventional steam plant for 160 psi 378 F can produce 100,000 kw net output.

For a liquid-metal-cooled fast reactor, the core would be 38-in. diameter and 38-in. high with sodium being heated from 600 to 900 F to supply steam at 485 psi and 750 F to a turbine plant developing 145,000 net kw.

These brief descriptions merely serve to indicate the variety of reactor designs the four groups have under consideration at present, and do not include a number of alternate types of superior characteristics that might be developed in time. These types supply the answer to "What can we build now?" and "Along what lines shall we start?" in order to have a working power plant within four or five years. All conclude that electric power generation from nuclear fuel is technologically possible and that reasonably operable plants can be developed when (1) power companies may buy, own, and sell fissionable materials, and (2) economic factors can be adjusted to make the cost of nuclear power comparable with present costs of power generation.

TABLE 2 DOW-DETROIT REACTOR CONFIGURATIONS

| Description | A-1 | A-2 | A-3 | B | C |
|---|---|---|---|---|---|
| | Radiator; liquid fuel, liquid coolant | Radiator; slurry fuel, liquid coolant | Radiator; liquid fuel, solid fertile material, liquid coolant | Radiator; solid fuel, liquid coolant | Liquid-liquid; liquid fuel, liquid coolant |
| Max output, kw heat | 25,000 | 460,000 | 75,000 | 450,000 | 220,000 |
| Max coolant temp available for steam generation, F | 900 | 1020 | 900 | 1020 | 930 |
| Electrical power output at 30% efficiency, kw | 7500 | 138,000 | 22,500 | 135,000 | 66,000 |
| Coolant material | Na | Na | Na | Na | Na |
| Melting temperature, C | 98 | 98 | 98 | 98 | 98 |
| Boiling temperature, C | 883 | 883 | 883 | 883 | 883 |
| Thermal conductivity, cal/cm/sec/C | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| $dc_p$, cal/cm$^3$/C | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Max circulating velocity ft/sec | 30 | 30 | 10(30) | 30 | 30 |
| Temperature rise, C | 130(260) | 130 | 140 | 280 | 300 |
| Max temperature, C | 480(610) | 480 | 480 | 550 | 500 |
| Min temperature, C | 350 | 350 | 340 | 270 | 200 |
| Max coolant temp limited by | Corrosion | Corrosion | Corrosion | Corrosion | Corrosion |

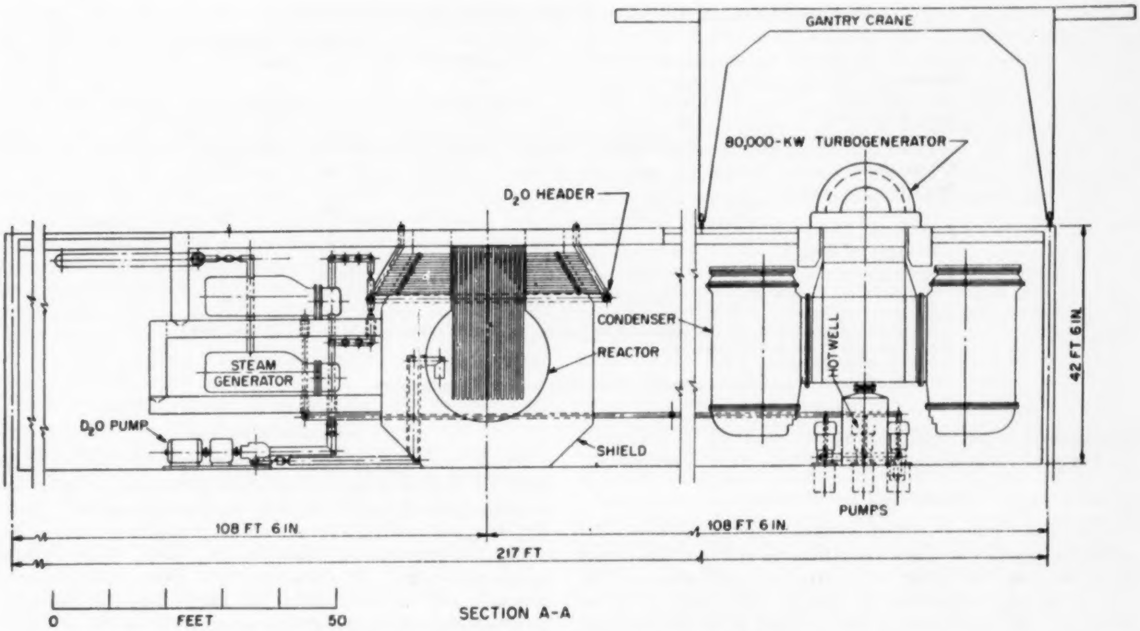



FIG. 2 HEAVY-WATER ($D_2O$) COOLED REACTOR FOR 200,000 NET KW

(Primary cooling system contains 250 tons of radioactive heavy water costing \$25 to \$40 million. This transfers heat to secondary nonradioactive steam plant to operate three 80,000-kw units.)

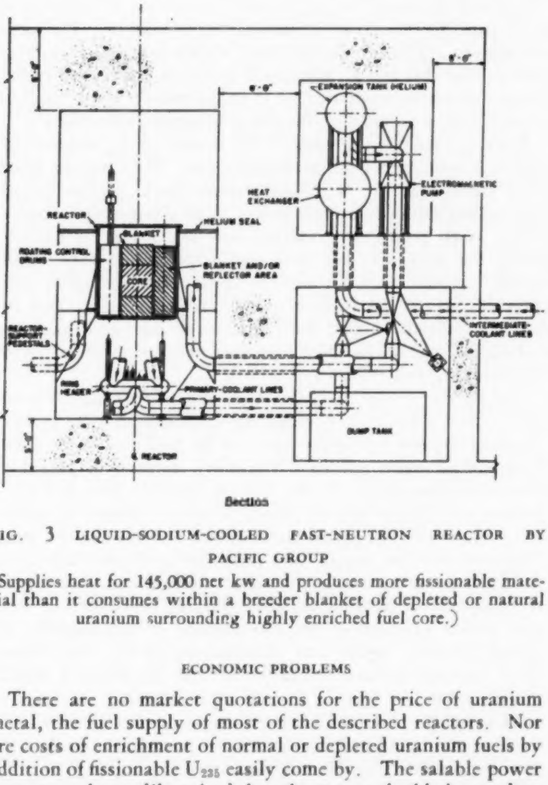



FIG. 3 LIQUID-SODIUM-COOLED FAST-NEUTRON REACTOR BY PACIFIC GROUP

(Supplies heat for 145,000 net kw and produces more fissionable material than it consumes within a breeder blanket of depleted or natural uranium surrounding highly enriched fuel core.)

### ECONOMIC PROBLEMS

There are no market quotations for the price of uranium metal, the fuel supply of most of the described reactors. Nor are costs of enrichment of normal or depleted uranium fuels by addition of fissionable $U_{235}$ easily come by. The salable power output can be readily priced, but the more valuable by-product of breeder reactors, fissionable plutonium, is difficult to evaluate. Thus the four groups, without stabilized costs for fuel supply or for values of resulting "ash" output, have concentrated on selection of a "feasible" reactor, have estimated the capital outlay for reactor and associated steam-turbine plant and noted certain added operating costs peculiar to reactor plants.

For example, the gas-cooled Chicago reactor is estimated \$7.7 millions with another \$4 million of boiler-plant equipment. However, the alternate heavy-water reactor costs \$48 million of which \$41 million represents cost of the heavy-water charge. Total plant cost of \$40 million for the former plant producing 46,700 net kw exceeds \$800 per kw; \$118 million for the heavy-water 211,500 kw exceeds \$550 per kw. On the other hand, the Monsanto-Union Electric report of total costs exclusive of land and financing costs range from \$110 to \$124 per kw as compared to conventional steam plant of \$169. See Table 3.

On the basis of general conditions in Detroit where an investment in boiler plant of \$83 per kw of maximum generator capability is normal, it would be possible to justify an investment in nuclear-reactor plant, including steam generators, up to \$235 per kw of capability if fuel, labor, materials, and supplies costs were exactly offset by sales of plutonium-bearing ash and if reactor design is certain to be economically sound for about 20 years.

The Pacific group estimates it would need \$51 million to construct a 145,000-kw plant (\$33 million of this in the reactor plant) or \$350 per kw as compared with \$140 per kw of steam plant. However, they visualize a future improved reactor plant for power generation only that might cost only \$30 million (16.6 of which is reactor plant) for 160,000 kw, or \$186 per kw and generate over a billion kwhr per year at 5.5 mills.

Thus the economic aspects sum up to (1) a large investment in reactor plant as compared to the portion of conventional steam plant it replaces; (2) operating costs such that power at less cost than steam plants can be possible only if by-product plutonium pays a large share of the total; and (3) there is hope that

TABLE 3 MONSANTO-UNION ELECTRIC ELECTRIC-POWER COSTS[a]

| | Case A | | Case B | | Modern coal-fired plant | |
|---|---|---|---|---|---|---|
| Capital cost $\$10^6$ | 26 | | 61 | | 44 | |
| Net output, kw | 210,000 | | 554,000[b] | | 260,000 | |
| Cost, dollars/kw | 124 | | 110 | | 169 | |
| | $\$10^6$/yr | Mills/kwhr | $\$10^6$/yr | Mills/kwhr | $\$10^6$/yr | Mills/kwhr |
| Depreciation[c] | 5.20 | 3.30 | 12.20 | 2.94 | 1.26 | 0.65 |
| Property taxes and insurance | 0.52 | 0.33 | 1.22 | 0.29 | 0.88 | 0.45 |
| Fuel cost (coal, $0.23 per $10^6$ Btu) | 0.0 | 0.0 | 0.0 | 0.0 | 4.63 | 2.37 |
| Operating cost | 0.79 | 0.50 | 2.10 | 0.50 | 0.98 | 0.50 |
| Total | 6.51 | 4.13 | 15.54 | 3.73 | 7.75 | 3.97 |

[a] Assumptions: Plutonium sale offsets all fuel costs; operating time, 7500 hr/yr; taxes and insurance, 2 per cent; and depreciation, 20 per cent.
[b] Heat rejected below 500 F.
[c] Twenty per cent on Cases A and B, 2.86 per cent for coal-burning plant.

development of improved reactors may result in "power-only" nuclear plants comparable in over-all costs with steam power.

### SOME TECHNICAL PROBLEMS

First and foremost among immediate problems concerned with the generation of nuclear power by utility companies is that purchase, ownership, or sale of fissionable materials by individuals or corporations is illegal. Obviously provision must be made for ownership and handling of fissionable materials before nuclear-power studies by industrial companies can be more than academic. Further, both relative and absolute costs of natural uranium metal, depleted uranium (from which some $U_{235}$ has been extracted), enriched uranium (from which some $U_{238}$ has been extracted), thorium, and other "fertile" materials will have to be established or assumed on the long-term basis during which an operating saving pays off on extra capital investment.

Secondly, if the safety formula for protection of the public derived for the Hanford reactors is to be applied to plants of the size and type being considered for power generation, very large land areas would need to be acquired for the "exclusion" area. It is doubtful if any corporation could contemplate acquisition of so much land, certainly an impossibility within reasonable distance of concentrated power loads. Reactor designs must be evolved which require exclusion areas very much smaller than those determined by the Hanford formula.

Thirdly, none of the existing reactor types fits exactly into the pattern of a large power-generating plant. Every component and composite of related components will have to be tested before construction of a full-scale reactor is started. The Monsanto-Union Electric group, for example, list their foremost problem as the reaction between sodium, either liquid or gas, and graphite under the temperature, radiation, stress, and other conditions which will exist in the proposed reactor. Possible graphite temperatures are not known, although an analytical survey is under way. Also, there may be embrittlement of thin cooling-channel tubes. Corrosion and erosion of fuel-element jackets by sodium under in-pile conditions is possible.

Corrosion and radiation effects are listed as problems requiring further development, research, and test by all groups. Refueling during operation has received much attention already but many more problems are anticipated in the presence of sodium in the vapor or liquid state.

Not the least among these very real problems is the evaluation of the pro's and con's of whether to concentrate first on a reactor type of established characteristics similar to the Hanford or Brookhaven units, to work along the lines of the heavy-water experience at Argonne National Laboratory, or to take the longer step toward fast-neutron breeder reactors at once.

### FUTURE POSSIBILITIES

The ultimate type of nuclear-reactor plant for power generation will depend largely on whether plutonium or other fissionable material continues to be needed for weapons. Reactors designed primarily for plutonium production require relatively low-temperature conditions in terms of economical power generation. On the other hand, severe corrosion, temperature, and radiation effects are imposed on the protective materials and sealing systems if reactors are to operate at higher temperatures and radiation intensities.

Most of the study work to date assumes that chemical and metallurgical processing of fuel and ash will be done in plants separate from the power installation proper and that some means will be found to pay for this processing in total or in great part by the value of fissionable by-product. The same assumption applies to the ultimate disposition of radioactive wastes, that this and all associated problems external to power generation can be accounted for in such a manner as not to affect seriously the economics of the power situation taken alone.

Reading between the lines of the several group reports one arrives at some important generalizations. The Chicago group flatly states that the gas-cooled reactor could provide a substantial beginning in atomic power with a minimum of interference with production reactors now under way or contemplated but they also list nine significant points that would rapidly obsolete such a reactor. These relate to higher temperature, greater production of fissionable material, uses for depleted uranium, higher burn-up rates of fuel, and operating techniques that allow more complete utilization of fuel with less charging and removal.

The Pacific group concludes that the water-cooled reactor has reached a point in engineering development that permits construction and operating costs to be predicted with a fair degree of accuracy, and that if primary emphasis is placed on plutonium production at the earliest possible date and for a definite production period, this type reactor would be attractive. However, the liquid-metal-cooled fast (neutron) reactor conserves uranium supply and promises to become adaptable to higher steam conditions. Further, they note that the liquid-fuel fast reactor appears to have greatest possibility of low-cost power production but the amount of development required prevents design and construction in the near future. They recommend that development and design of a liquid-metal-cooled fast breeder reactor with solid-fuel elements be undertaken promptly but express the hope that work will be done on the liquid-fuel breeder reactor in time to obsolete the need for constructing the solid-fuel type.

Need for early design and construction of plutonium-producing reactors led the Monsanto-Union Electric group to con-

centrate on sodium cooling of the Hanford graphite reactors but their report visualizes other types including heavy-water and light-water moderated reactors with enriched solid fuels, and liquid-fuel types.

The Dow-Detroit group proposed, as early as December, 1951, that a joint research and development program and engineering study be undertaken, supported in substantial part by the companies but utilizing the special facilities of AEC as well. This study aims at design of a fast breeder reactor with high coolant temperature utilizing easily fabricated mobile fuels closely integrated with a metallurgical separations process. To select an approach consistent with long-range requirements but capable of early development, this group has concentrated on a liquid-metal-cooled fast breeder reactor with solid-fuel elements of a uranium alloy. The aim is to simplify fabrication and processing of fuel and to use uranium alloys in a breeder blanket to produce plutonium.

To be economical such a reactor should utilize low-cost fuel, that is, should convert thorium or depleted uranium into fissionable material for fuel at a greater rate than fissionable material is burned. To be practicable it should be so designed as to take advantage of low-cost processing and recovery of fissionable material, preferably by continuous removal and segregation of the fission products and the fuel should preferably be uncanned, and mobile or fluid. The reactor furthermore should be inherently self-regulating and require a minimum exclusion area.

Their report concludes that the chances are excellent that molten-metal processes can be developed into a superior separations method more compatible with present reactors and less expensive than the aqueous processes, particularly if machining and jacketing of fuel slugs can be avoided. Fuel should be mobile to facilitate frequent and rapid processing, preferably in the liquid state at all times. If this is not feasible, solid-fuel elements should be of such shape as to be easily fabricated by remote control, such as simple castings.

Among fluid-fuel possibilities, each with distinct disadvantages, are (1) eutectics of uranium or plutonium with melting points above 930 F; (2) slurries such as the dispersion of intermetallic compounds or alloys of uranium in low-melting-point alloys; and (3) fused salts. Much development work is required on any of the fluid-fuel systems as well as on a reactor design to make use of them. For reactors to be built within a reasonable time, solid fuel may be necessary, although some of the advantages of the fluid fuels can be gained through the use of relatively low-melting-point materials of which at least one uranium alloy is a reasonable choice for the initial effort.

Of the reactor type which might meet all or part of the desired requirements some designs are (1) a jet-mixed centrifugally separated liquid-cooled reactor with liquid fuel and continuous reprocessing, Table 2, type C; (2) a reactor having liquid fuel in a "pot" with the coolant in tubes, Table 2, type A-1; and (3) coolant outside fuel tubes with liquid or mobile fuel inside tubes, with or without fast continuous reprocessing.

From the power viewpoint, the AEC projects on breeders are the most important work under way. The commercial future of atomic power appears to be dependent on the development of the breeder reactors, that is, those that produce more fissionable material than is burned. From an economic viewpoint, the potential net gain in fuel in the breeder reactors promises a margin to offset the high investment cost of the reactors. If breeding is feasible, higher costs associated with nuclear power may be compensated by the sale of surplus fissionable material as fuel.

From the design viewpoint, rapid and continuous chemical processing offers great potentialities in reducing costs. There is need for closer integration of the reactor and the separation process. If the goal of flowing fuel through a reactor with concurrent development of a lower-cost integrated continuous separation process can be reached, an important improvement in the prospects for nuclear power will have been made.

The chances are now excellent that molten-metal processes can be developed. However, much development work will be necessary on any of the fluid-fuel systems. The ultimate objective might well be a reactor of which the core is entirely molten metal surrounded by a depleted-uranium breeder blanket to produce plutonium.

### CONCLUSIONS

Four teams of the best available power and process engineers have studied the available experience and technology and each separately concluded that (1) generation of electric power from nuclear reactors is possible in size units of interest to utility power systems; (2) certain less-than-perfect plants can be designed and constructed in five years or less; (3) these can be so designed as to produce fissionable materials for weapons or for power production or both, and (4) economics are within a comparable range of present costs of steam power.

Each group seeks a better reactor than the one selected for first attention. Higher steam temperatures would be better for power generation. Other advantages are outlined in the hope someone will find the key. More problems are detailed than solutions but the lines of study are indicated.

The significant point right now is that these teams have been at work, that their preliminary studies lead all to want to continue, that co-ordination of the work is a fact. It is equally important that an avenue of approach now exists by which the work can gradually be declassified and made useful to others who can contribute.

## Titanium Corrosion Tests

ADDITIONAL evidence that titanium is one of the most corrosion-resistant metals in the world was offered by the U. S. Bureau of Mines following studies at its Eastern Experiment Station, College Park, Md.

The experiments cover the galvanic corrosion behavior of titanium under varying conditions and are described in a technical report recently released.

Galvanic corrosion occurs when two dissimilar metals, joined in the presence of moisture, form an electric cell. A current is established between them and one of the metals corrodes. Since titanium often will be coupled with other metals in military and other types of equipment, the Interior Department agency is experimenting to find out how and where it can be used most advantageously.

These experiments showed that Bureau-made titanium did not corrode when coupled with magnesium, zinc, aluminum, iron, copper, or stainless steel in a 3 per cent salt solution—approximately that of sea water. All other metals, except stainless steel, did corrode, the report states.

Various concentrations of hydrochloric acid then were used. Titanium corroded when joined to copper in sealed bottles containing hydrochloric-acid solutions aerated by helium. However, when air was substituted for the helium, the copper corroded and titanium was not affected. The addition of dissolved copper to the solution made the titanium even more corrosion-resistant, according to the Bureau's findings.

This "Report of Investigations 4965—Certain Aspects of the Galvanic Corrosion Behavior of Titanium," is available from the Publications Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

# BRIEFING THE RECORD

## Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

## Atomic Energy

### *Submarine Thermal Reactor*

THE submarine thermal-reactor prototype plant has successfully entered its first phase of operation at the United States Atomic Energy Commission National Reactor Testing Station in Idaho. This phase is known as "criticality" and means that the nuclear components of the reactor are sustaining an atom-fissioning chain reaction.

Further testing and operation will continue and gradually the plant will be brought to full power in order to determine the operating characteristics of the similar plant which will power the U.S.S. *Nautilus*, and to train the crew for this vessel. It is expected that such operation will add further to the significant contributions to reactor technology already made through experimentation, design, and construction of the STR.

The STR plant in Idaho and the similar plant for the U.S.S. *Nautilus* have been a joint project of the AEC's Argonne National Laboratory, the Atomic Power Division of the Westinghouse Electric Corporation and the Electric Boat Division of the General Dynamics Corporation, assisted by numerous subcontractors.

The project has been under the administrative and technical direction of the AEC-Navy group in the Division of Reactor Development of the Atomic Energy Commission.

### *New AEC Laboratory*

A new Atomic Energy Commission laboratory located in Winchester, Mass., is in full operation. The primary objective of the laboratory, operated by the American Cyanamid Company under contract to the Raw Materials Division of the AEC, is the development and improvement of processes for the recovery of uranium from its ores.

The new laboratory is well equipped for studying all phases of mineral dressing, and one of its functions will be to undertake the vitally important task of developing methods for effective and economical recovery of uranium from low-grade ores and other low-grade uranium-bearing materials.

The laboratory was started at the Watertown, Mass., Arsenal in 1945, under the direction of Dr. A. M. Gaudin, professor of mineral engineering of the Massachusetts Institute of Technology. At that time the contract with the Atomic Energy Commission was with M.I.T., which built up the staff from a few people to about sixty. During this period the laboratory made a number of extremely valuable contributions to process development for uranium recovery.

As the demand for uranium increased, the scope of the operations of this laboratory became broader and eventually resembled the development function of regular commercial metallurgical testing facilities. M.I.T. decided it should no longer carry on the operation of the laboratory, since it involved work more of a commercial nature than that normally handled by an academic institution. Consequently, in 1950 the American Cyanamid Company was awarded the contract to operate the facility. The operations continued at Watertown until December, 1952.

### *B. & W. Atomic Power Division*

Establishment by The Babcock & Wilcox Company of an Atomic Power Division was announced recently. B. & W. has been active in nuclear work since 1943, having been engaged in the Manhattan project which resulted in the development of the first atomic bomb. It played a large part in engineering work on the reactor at the Brookhaven Laboratory on Long Island, has done, and still is doing, work on the development of the "atomic engine" for the nuclear-powered submarines, and is doing advance studies on the application of atomic power to larger Navy ships. Babcock & Wilcox is also actively associated with Detroit Edison and Dow Chemical Companies in work of applying atomic power to the generation of electricity.

Alfred Iddles, Fellow ASME, president of B. & W., pointed out that the company has been building steam-generating equipment since 1867 and since the utilization of nuclear reaction requires, basically, that heat be transferred to steam power, then to electric energy, the company is in a natural position to contribute significantly in the atomic-power field.

**How to Obtain Further Information on "Briefing the Record" Items**

**MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.**

**For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.**

### *Nuclear-Power-Reactor Studies*

The Atomic Energy Commission has completed negotiation of an agreement with the Pioneer Service & Engineering Company, Chicago, Ill., together with the Foster Wheeler Corporation, New York, N. Y., governing the nuclear-power-reactor study which these two companies propose to conduct during 1953. This negotiation was begun some time ago when the Commission accepted the Pioneer Service—Foster Wheeler proposal to engage in the activities of the Industrial Participation Program. These activities include a survey of the feasibility of design, construction, and operation by private industry of power-producing reactors.

The Pioneer Service & Engineering Company serves the electric-utility industry as design engineers and consultants in all phases of the electric-power business. For the purposes of this reactor study, Pioneer's staff has been augmented by a nuclear physicist and a nuclear engineer. Several of Pioneer's regular clients, including large utilities in the midwest and western states, have agreed to support the study.

Foster Wheeler Corporation is widely known in the field of design and manufacture of steam generation, heat exchanger, petroleum refining, and chemical-process equipment. Chemical processing plays a much bigger role in nuclear power than in conventional power.

All costs of the Pioneer Service—Foster Wheeler study will be borne by the two companies. The term of the study will be one year, after which time a complete report of the findings and recommendations of the two companies will be submitted to the Commission.

Specifically, the purpose and scope of the Pioneer Service—Foster Wheeler agreement are as follows:

1 To determine the engineering feasibility of their designing, constructing, and operating a nuclear reactor.

2 To examine the economic and technical aspects of building this reactor in the next few years.

3 To determine the research and development work needed, if any, before such a reactor project can be undertaken.

4 To offer recommendations in a report to the Commission concerning such a reactor project and industry's role in undertaking and carrying it out.

## Zirconium Fabrication

ZIRCONIUM, a key metal being used in construction of the first atomic submarine engine, will be fabricated in quantity "on a full commercial scale" during 1953, according to a paper by Dr. R. B. Gordon and W. J. Hurford of the Westinghouse Atomic Power Division, Pittsburgh, Pa., delivered before the American Society for Metals meeting in Los Angeles, Calif., recently.

Starting with laboratory work on two one-pound pieces of zirconium in 1949, industry now is forming, rolling, and machining parts from ingots a foot in diameter and weighing up to 500 lb.

Since the start of 1949, Westinghouse has been at work on the nuclear reactor and associated propulsion equipment for the first atomic submarine—the U.S.S. *Nautilus*. It is being built by the Navy and U. S. Atomic Energy Commission.

Fabrication of zirconium ingots into useful shapes, and in quantities exceeding a few pounds, began in 1949, they said.

Since that time there has been a steady increase in the quantity and quality of zirconium fabricated and in the variety of shapes produced.

Small-scale laboratory work grew to pilot-plant operations of considerable magnitude during 1950 and 1951. With a continuing increase in Atomic Energy Commission requirements for zirconium, the Bureau of Mines in 1952 began production of the first commercial-size ingots. Experimental fabrication in commercial facilities was commenced during the same year. In 1953 it is anticipated that quantity fabrication of zirconium on a full commercial scale will be achieved, they pointed out.

For the water-cooled nuclear reactor such as the one Westinghouse is building for the *Nautilus*, zirconium has been ranked only second in importance to uranium as a vital material. Lighter than steel, it has remarkable corrosion resistance, an extremely high melting point, and is strong and workable. Most important for its use in a nuclear reactor is the fact that it does not absorb and thus "waste" neutrons—the atomic particles used to bombard uranium atoms thereby producing the nuclear reactions necessary to keep the atomic power plant running.

## Umohoite

A NEW species of uranium mineral, named umohoite, consisting of 48 per cent uranium, combined with molybdenum and water, has been identified in the Columbia University mineralogical laboratory. Natural pitchblende, most common source of uranium, contains an average of from 50 to 65 per cent of the radioactive element.

Details of the discovery were forwarded to the Atomic Energy Commission's New York office, following notification by Prof. Paul F. Kerr, professor of mineralogy at Columbia. Mineral research undertaken in co-operation with the Division of Raw Materials of the AEC led to discovery of umohoite.

Professor Kerr and Gerald P. Brophy, a graduate student assistant, brought back samples of the black flaky mineral from the Freedom Two uranium mine at Marysvale, Utah. Some 25 lb of ore, taken from a number of veins, was collected last summer and is still being analyzed with the mineralogy department's x-ray spectrometer. Discovery of umohoite came half way through this analysis; a second half of the ore sample is yet to be investigated.

According to Professor Kerr, the mineral is a new species not previously described. It contains molybdenum and water in addition to uranium, being a hydrous uranium molybdate. The name umohoite is given to the mineral by combining the chemical symbols U, Mo, H, and O with the mineral suffix "ite."

Umohoite contains about 49 per cent uranium, Professor Kerr said, but it is not yet known how widely the mineral is distributed, occurrences thus far known being limited to one mine. Marysvale ore, however, frequently contains an unusual amount of molybdenum which could be attributed to umohoite. It is also likely that other occurrences of umohoite may be found in the West.

Tracing the origin of the newly identified mineral, Professor Kerr explained that it is associated with pitchblende of Tertiary age—estimated by geochemists to be about 25 million years old. Deeply eroded throats of old volcanoes are found in the Marysvale district, with occasional hot springs not far away. Uranium is believed to have been deposited by solutions arising from some of these dying volcanoes.

While small amounts of the mineral are fairly widespread in distribution, according to Professor Kerr, samples of pure material are separated only with great difficulty. In fact, for testing purposes small crystals of umohoite are picked out under a microscope. The crystals appear to be irregular flat plates, but are shown by x-ray studies to be symmetrical hexagons in shape.

# Oil-Shale Retort

HIGH yields of better products now are being obtained from oil shale by a new and promising retorting process developed at the Petroleum and Oil-Shale Experiment Station of the Bureau of Mines in Laramie, Wyo.

Preliminary test operations in a one-ton a day pilot plant employing this high-temperature "entrained-solids" process have disclosed that it offers the following definite advantages:

1 The retorting or oil-extraction operation that once required hours in batch-type units is completed in three seconds by a simple and continuous method.

2 The major products are a high-quality oil and high-octane gasoline, both far superior to those produced by other types of retorting.

3 Large quantities of premium-priced aromatic chemicals, such as benzene and toluene, also are obtained, together with such important chemical raw materials as ethylene, propylene, butylene, and butadiene.

4 The process is flexible, for the time and temperature of retorting can be varied at will to control the quality and type of products.

Results achieved with this retort have so interested one of the major chemical companies that it is exploring the possibilities of using oil shale as a source of strategic chemicals now in demand, the Bureau said.

Essentially, the pilot plant consists of a gas-fired furnace containing hairpin-shaped alloy-steel retort tubes $3\frac{1}{2}$ in. in diam, a spent-shale recovery system, a liquid-recovery system, and a gas-sampling system.

Oil-shale particles, crushed to $\frac{1}{4}$-in. size or smaller, are picked up by superheated steam and carried swiftly through the retort tubes at any desired temperature from 900 to 1800 F. The shale is retorted almost instantaneously, and the oil-bearing vapors pass on to the spent-shale recovery system. There, 98 per cent of the spent or waste shale entrained in the steam is removed by a series of cyclones and dust separators.

The oil or vapor-recovery system consists of two main parts: (1) Two water-cooled condensers operating at atmospheric or retort pressure that remove the water and heavy-oil vapors from the stream; and (2) two additional condensers, one water-cooled and one refrigerated, that operate at 100 psi and remove the lighter vapors. A continuous sample of noncondensable gases is collected in one of two 50-cu ft gas holders, and the remaining gases are flared.

Convenient natural gas is used to fire the furnace, but fuel oil produced in the process could be used equally well, it is pointed out. Moreover, although steam from a low-pressure boiler is being employed as the entraining medium, any entrainment gas could be used. Flue gases leaving the furnace superheat the steam before entering the stack.

According to the Bureau, crude-oil yields as high as 21 gal per ton have been obtained from shale analyzing 30 gal per ton and naphtha yields have ranged up to $6\frac{1}{2}$ gal per ton. Considerably more gasoline can be made from the retort gases and by hydrogenating the heavy-oil fractions. The feed rate or shale-handling capacity is much higher than in the average retort, amounting to 8050 lb per hr for each square foot of cross-sectional area in the retort tubes.

A disadvantage of the process is that it requires finely crushed shale, and crushing is expensive, it is noted. Shale particles of $\frac{1}{4}$-in. size, the largest tested thus far in the pilot retort, were handled satisfactorily, however.

A commercial retort using this process might well be operated to advantage in conjunction with a conventional retort, using the shale fines that now must be discarded. Moreover, it is possible that the value of the premium products obtained would be adequate to support the costs of preparing finely crushed shale in an independent operation. However, no economic studies have yet been made on this question.

# Continuous Casting

RECENTLY, members of the technical press were afforded the opportunity to inspect the American Smelting and Refining Company's continuous-casting process in Barber, N. J. This plant, which continuous-casts copper-alloy rods, tubes, and shapes, has been in operation since September, 1947.

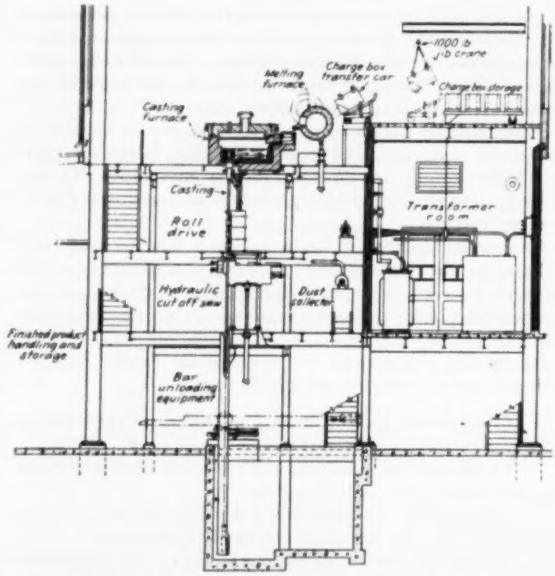



FIG. 1 CROSS-SECTIONAL DRAWING SHOWING ALL MAJOR ELEMENTS IN THE ASARCO CONTINUOUS-CASTING PLANT AT BARBER, N. J.

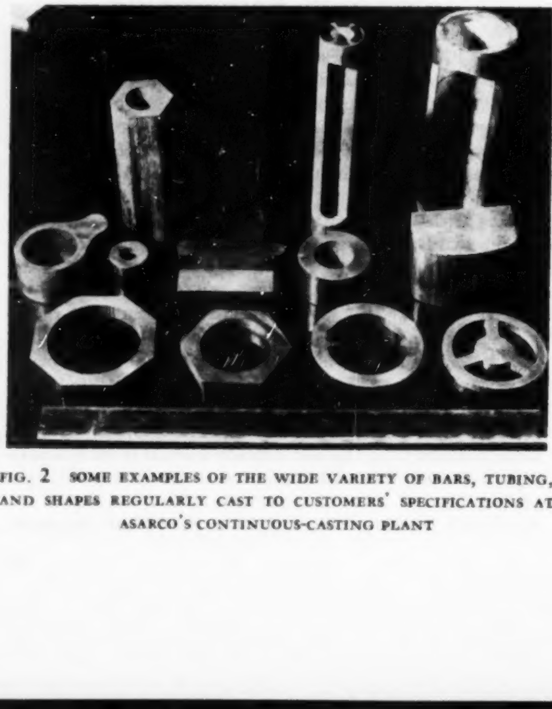


FIG. 2 SOME EXAMPLES OF THE WIDE VARIETY OF BARS, TUBING, AND SHAPES REGULARLY CAST TO CUSTOMERS' SPECIFICATIONS AT ASARCO'S CONTINUOUS-CASTING PLANT

An article, "Asarco Continuous-Cast Bearing Bronzes," by J. S. Smart, Jr., and P. J. Kranz of American Smelting and Refining Company, appeared in the April, 1953, issue of MECHANICAL ENGINEERING. A description of the continuous-casting process was given and data were furnished covering the physical properties of the popular bronze bearing and bushing alloys. In addition, the results of a dry-wear testing program were also included.

As a supplement to the April article, Figs. 1 to 6 describe pictorially some of the steps in this interesting process. Briefly, referring to Fig. 1, molten metal, supplied by a rotary Detroit melting furnace, is maintained at a proper temperature in the casting crucible. Solidification of the rod or tube takes place in a self-lubricating, water-cooled graphite die. Driving wheels, mounted directly beneath, withdraw the solidified product continuously at a controlled speed.

A traveling saw, mounted below the driving rolls, is engaged at proper intervals to cut uniform lengths.

The casting crucible is totally enclosed within the furnace and is maintained under a nitrogen atmosphere. The process, which operates as a true gravity-fed bottom-flow casting method, precludes the possibility of trapping incidental dirt and dross. Such foreign matter as may enter the system floats on top of the melt without turbulence to carry it into the product. Freezing from the bottom upward is ideal for permitting the escape of any dissolved gases which are liberated during solidification. The molten bath, functioning as a huge riser and head, prevents the formation of shrinkage cavities.

FIG. 3 CHARGES FOR A SPECIFIC BRONZE ALLOY ARE SHOWN ON THE FLOOR IN THE FOREGROUND, READY TO BE LOADED INTO CHARGE BOXES AND HOISTED TO THE MELTING FLOOR

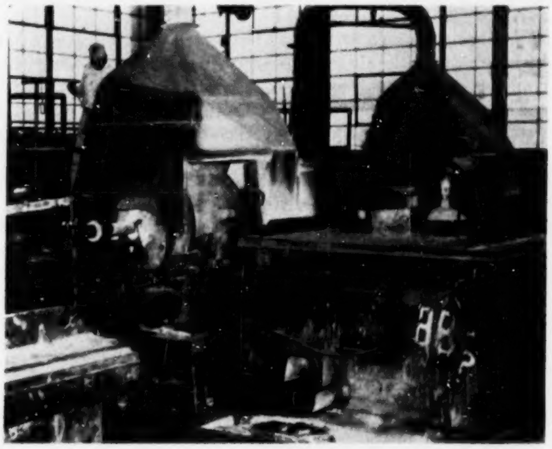


FIG 4 A ROTARY DETROIT FURNACE, *left*, IS USED TO MELT CHARGE

(Molten bronze is poured from this unit into the holding furnace, which encloses the casting crucible, *right*. From the crucible, the metal enters a graphite die, under gravity feed.)

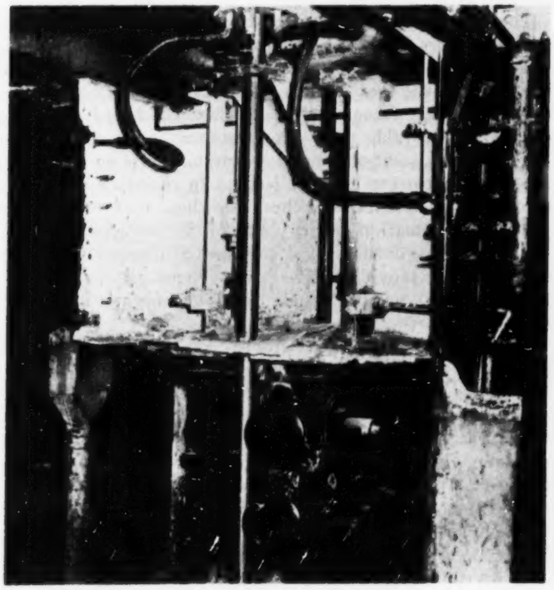


FIG. 5 AT TOP OF THIS PICTURE, BRONZE BAR IS SHOWN LEAVING BOTTOM OF WATER-JACKETED GRAPHITE DIE, ALREADY SOLIDIFIED TO SIZE

(Drive rolls, shown at bottom, control the speed at which casting takes place.)

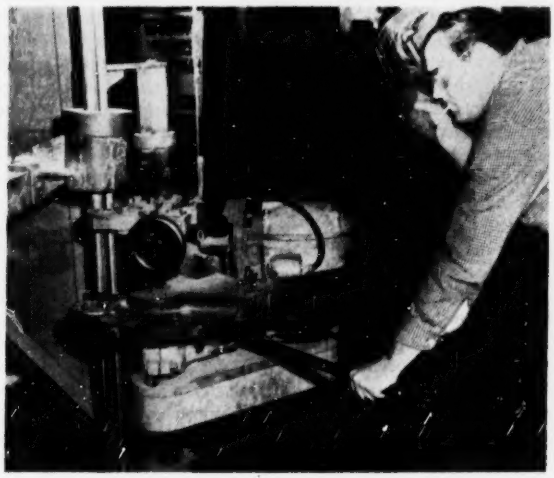


FIG. 6 CUTTING TO CUSTOMER SPECIFICATIONS IS ACCOMPLISHED BY CLAMPING THIS TRAVELING SAW TO THE BARS

(Maximum length is 20 ft. Note that two small-diameter bars are being cast at the same time in this case. Depending on diameter, as many as four or five bars can be produced simultaneously.)

# Waste-Heat Boiler

PLANS to recover vital copper in one of the richest undeveloped deposits on the North American continent called for a specially designed boiler to utilize what would otherwise be waste heat from a copper reverberatory furnace. The boiler, designed and being built by The Babcock & Wilcox Company, will supply steam to a turbogenerator to furnish power for the projected development.

Scene of the operation is the White Pine copper smelter 18 miles southwest of Ontonagon, Mich. This work is being done by the White Pine Copper Company, a wholly owned subsidiary of Copper Range Company, Boston, Mass.

The ore mineral is mainly chalcocite, a cuprous sulphide ($CU_2S$). The total ore reserves amount to 309 million tons averaging 21.3 lb of copper per ton.

The boiler, which will be about six stories high, is to be in line with and following the reverberatory furnace in which the copper ore is melted.

The gases or products of combustion, heavily laden with slag particles and dust, leave the reverberatory furnace at a rate of approximately 143,000 lb per hr at a temperature of 2600 F, entering, first, the waste-heat boiler furnace, then passing through the superheater and convection section of the boiler.

The hot slag particles will fuse on any surface with which they come in contact, especially if the surface is hot. To cope with this problem the waste-heat boiler was specially designed with tube-to-tube water-cooled wall radiation chamber, widely spaced platten-filled chamber and superheater chamber, and a crossflow convection boiler section, B. & W. engineers explained.

The heat absorption of the water-cooled furnace walls and the water-cooled plattens reduces the temperature of the incoming gases 400 to 500 F before they enter the superheater chamber. Thus the suspended slag particles are cooled to a dry ash which drops to the furnace hopper and into the hoppers under the boiler from which it is returned to the reverberatory furnace for retreatment to reclaim the copper.

The parallel, instead of the usual staggered tube arrangement makes cleaning more effective. This is accomplished by automatic telescopic soot blowers, located in lanes between the plattens, superheater, and boiler convection sections, periodically blowing high-pressure steam through nozzles across the boiler.

This arrangement prevents slag accretion on tubes which would otherwise necessitate hand lancing, a time-consuming and expensive operation. Aside from the considerable time and expense saved, this arrangement insures continuous operation of the boiler.

To minimize draft loss and insure against sulphurous gases leaking into the boiler from where men work, there will be a single-pass horizontal cross-gas-flow arrangement from the reverberatory furnace outlet through the waste-heat boiler and to the balloon flue inlet.

Using this waste heat from the reverberatory furnace instead of fuel for the generation of steam, the waste-heat boiler recovers about 50 per cent of heat in the fuel originally supplied to the reverberatory furnace.

The boiler is designed to generate steam at 885 psi at a temperature of 920 F at the superheater outlet. The steam generated is used not only in the power plant, but a portion is used to preheat combustion air, by means of steam air heaters, for the copper reverberatory furnace.

At such times as the reverberatory furnace may be shut down for repairs, the boiler, by a special arrangement, can be fired with pulverized coal, thus assuring continuous full production of steam at all times.

A pulverized-coal system, including distribution and burning equipment, will also be installed by B. & W. There are three pulverizers, two of which will normally be used to fire the reverberatory furnace. The third, through a system of interconnected piping, will serve as a stand-by unit to insure uninterrupted operation and will also intermittently supply pulverized coal to a storage system. Pulverized coal from this storage system will be used to fire a holding furnace, a refining furnace, and a copper converter.

An innovation in the smelting industry is the completely automatic control system which will permit firing of the reverberatory furnace from a central control center. From the same push-button panel engineers can operate the waste-heat boiler, coal pulverizers, raw coal conveyers, and the pulverized-coal distributing system.

# Photon

A COMPLETE book making use of a new photographic type-composing machine has recently come off the press, it is revealed in the *Industrial Bulletin* of Arthur D. Little, Inc., Cambridge, Mass. The new process involves preparation of a film "proof," from which the final printing plates are prepared either for offset or letterpress, with no conventional lead type being used.

Heart of the new process, developed by the Graphic Arts Research Foundation, Inc., of Cambridge, Mass., is the Higonnet-Moyroud machine, now known as the Photon. A simple piece of office machinery, a typist can compose printed material in any of 16 complete fonts of type at sizes ranging from 5 to 36 points, all at a speed controlled only by the typist's ability to operate a standard electric typewriter. Not only can type styles be mixed within a line by the Photon, but point sizes and type families may also be mixed without interfering with alignment or justification, i.e., spacing of the line, which the machine performs automatically.

The operator uses a standard electric-typewriter keyboard with four extra keys and a fifth row of keys which provides for corrections, eliminations, automatic centering, insertion of spacing, and the like. When a key is depressed, two "memory" devices are actuated. One of these is a board consisting of rows of movable pins. For instance, when the key for "m" is struck, some of the pins are mechanically pushed out to form a code pattern for that letter. In the second memory, consisting of electrical switches, like those used in dial telephoning, information on the width of the character is stored. When the typist finishes a line, this device calculates how much space must be provided between the letters and the words to make the line come out to just the right length (to "justify" the line within the given margins).

The actual type characters to be "set" by the Photon are printed on a continuously rotating glass disk, with different type styles arranged in concentric rings around the disk. As the machine operates, a reading carriage travels over the "pinboard," and electrical "feelers" read the pattern of pins to discover which letter should be printed next. Electric impulses from the feelers set off a brief, but intense, flash of light from a strobotron tube (commonly used in high-speed photography), when the proper letter on the revolving disk passes before the tube's optical system, and the image of the letter falls on the final photographic film. Meanwhile, the switch memory adjusts the horizontal position of the letter image on the film, to insure that a well-set page results. When the page is finished, the film is removed and developed.

Cleanness of the typesetting is one of the chief characteristics of Photon operation. The character of the final image is de-

termined throughout by optical or photographic means, and there is no fuzziness in printing, such as that associated with the customary lead characters. By simple switch operations the operator can change the size of the letters (by changing lenses within the machine) and can choose one of the 16 type faces available on a single disk.

Judging from the cost savings attributed to the machine, in comparison with standard equipment, it should find a ready market, the *Bulletin* points out. For example, the glass scanning disk with its printed type fonts contains the equivalent of \$25,000 worth of linotype matrixes weighing more than two tons, and requiring more than 90 cu ft of storage space. Moreover, maintenance should be simple, since keyboarding, coding and decoding units, and photographic elements have been constructed as plug-in elements which may be readily replaced.

Ten production models of the Photon are now being assembled by Photon, Inc., licensees under Graphic Arts Research Foundation patents, and it is expected that these ten will be placed in commercial operation. The first machines will be applied to a number of different printing problems, including newspaper and book publishing.

Successful operation in the field, together with its qualities of simplicity, high-speed operation, and versatility, should gain for the Photon the status of a major advance for the printing industry, the *Bulletin* concludes.

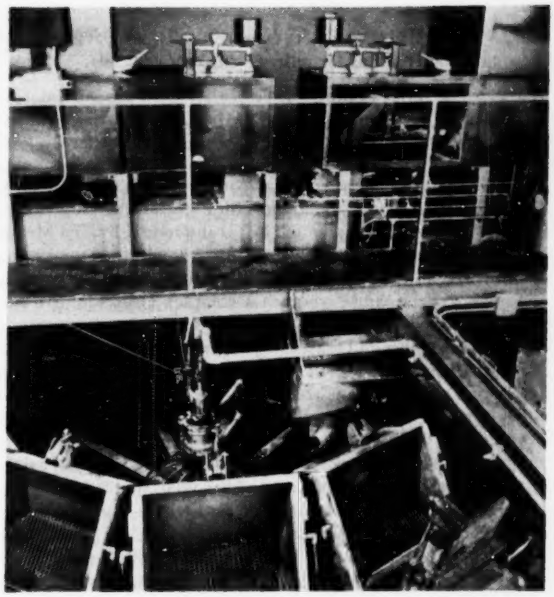


FIG. 8 AUTOMATIC PROPORTIONING AND BLENDING EQUIPMENT AT THE TOP OF 12-STATION SHELL-MOLDING MACHINE

# 12-Station Molding Machine

A 12-STATION unit, that will make approximately 500 shell molds per hour, has been designed and built by Mechanical Handling Systems, Inc., Detroit, Mich. Completely automatic, the machine requires only one man for operation. Pattern size on the standard machine is 28 × 22 in.

Operation of the unit is said to be smooth and continuous and mechanically simple. Beginning at left in Fig. 7 and traveling counterclockwise, a finished shell mold is removed from the pattern. Next, the pattern carriage moves up and engages the sand-resin hopper. Pattern and hopper, clamped tightly together, swing forward to below the horizontal, the material falls on the pattern, and the shell mold is formed.

Pattern and hopper now rise, the hopper is disengaged, and the pattern carriage, with its soft shell mold, returns to the horizontal and enters the oven. The mold travels through the oven, which is heated with gas-fired radiant burners, and is

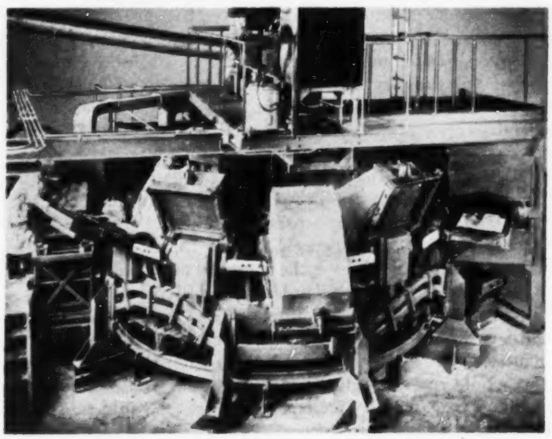


FIG. 7 12-STATION MACHINE IS CAPABLE OF PRODUCING 500 SHELL MOLDS PER HOUR

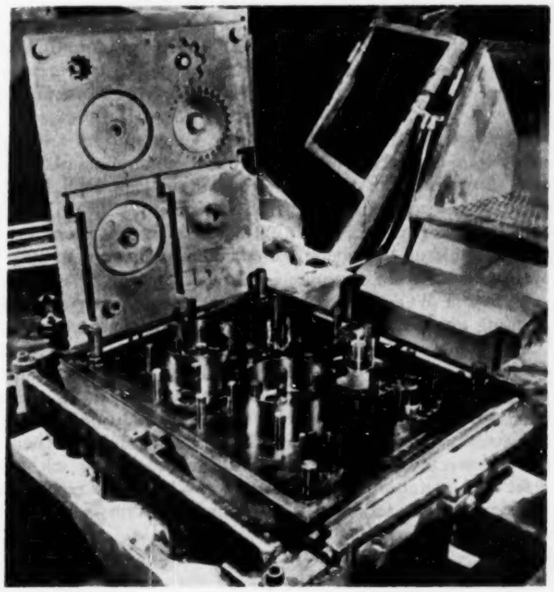


FIG. 9 CLOSE-UP OF A PATTERN AT THE MOLD DELIVERY POSITION OF THE SHELL-MOLDING MACHINE SHOWS TYPICAL CLEAN, SHARP, ACCURATE MOLDS PRODUCED

fully cured when it emerges at station at the far left of the photograph. Here the mold-release pins lift automatically, the mold is removed, and the cycle starts again.

At the top of the machine is located the automatic proportioning system for sand, resin, and wetting agent. These materials are thoroughly mixed and are deposited in controlled quantity in the hoppers at each revolution of the machine.

Pattern plates may be changed quickly, without stopping

the machine, which provides for extreme flexibility of production. The machine may be operated with all patterns producing the same molds, or with 12 different patterns.

## Metal-Cutting Agent

DEVELOPMENT of a Dynatomic metal-cutting agent, Metalloid WOS, for all machining and grinding operations, soluble in both water and oil, is announced by The Metalloid Corporation, Huntington, Ind. An odorless, nontoxic, sulphur-free, solublized organic condensate containing chlorine, nitrogen, oxygen, and carbon in a complex molecule, the material is said to be nonstaining for ferrous and nonferrous metals except some copper and brass alloys which will discolor slightly if the product is allowed to remain on the work for a period in excess of 12 hours. It is completely safe for use on silver and silver alloys.

Metalloid WOS functions on the Dynatomics heat-limiting principle, holding temperatures of tool and work well below critical annealing temperatures. This is accomplished by releasing free atoms at the point of cut, which unite with the active metal to cause embrittlement and reduce the plastic flow of the metal during the cutting operation. As a result, tool and workpiece remain cooler, internal stress and distortion are eliminated, and surface-finish quality is greatly improved.

The material may be used on either ferrous or nonferrous materials in undiluted form or mixed with water or oil. For general machining operations, dilutions are recommended 1 to 3 with water, paraffin, or naphthenic oil. Surface-finish quality and tool life are directly proportional to the concentration of WOS used. Tool life increases of 200 to 500 per cent may be obtained with proper application, according to the manufacturer.

Metalloid WOS readily emulsifies in water to form a stable emulsion in either hard or soft water with a minimum of foaming. Evaporation of water, when used in emulsion form, leaves a soft, low-viscosity film of good lubricating value. Due to unusual detergent properties, WOS will remove "caked on" soil or "build up," commonly found on machines due to use of ordinary cutting oils or grinding fluids.

Metalloid WOS is recommended for use in every type of grinding machine regardless of the operation or the material being ground. The material is said to increase wheel life a minimum of 100 per cent and to give from 3 to 5 times more pieces per dressing over straight oil, and 10 to 15 times more than other water-soluble fluids. In addition to this, the manufacturer states that WOS will also eliminate burning and cracking of work, providing free-cut pieces without glaze and metallurgical disturbance. Where this trouble is encountered, best results will be obtained with fine grain (150-180) soft bond grinding wheels.

## Airdock

AN "airdock" which would revolutionize present airline methods of loading and unloading passengers, baggage, and cargo has been designed by United Air Lines and now is under study for initial installation.

The proposed structure would be equipped with Whiting Loadair tracks, conveyer belts, and other devices for mechanized loading and unloading of aircraft. An incoming plane would be taxied onto Loadair tracks, then towed to a predetermined position where gas, oil, and other supplies would be available at fixed locations.

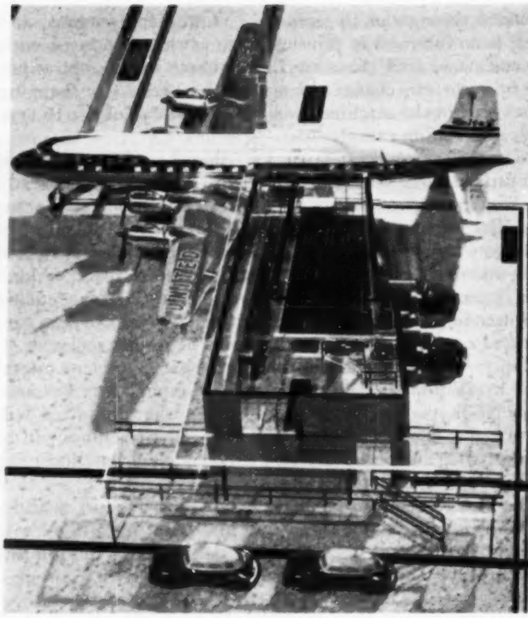


FIG. 10 BUILDING MODEL OF PROPOSED AIRDOCK

(Transparent roof on new airdock conceived by United Air Lines shows passenger waiting room, *foreground*, with corridor leading directly to door of Mainliner. Area flanking corridor contains washrooms, an office, and space for outgoing flights. Stairway from waiting room goes to baggage-claiming counter where bags are delivered by conveyer belt. Vertical lines at top are Whiting Loadair tracks, a key element in the dock.)

Passengers would deplane directly onto the second floor of the airdock, thus eliminating ramp stands and providing shelter in bad weather. By the time they walked to the baggage-claiming counter on the first floor, their luggage—whisked in by conveyer belts—would be arriving for pickup. Air mail, express, and freight meanwhile would be swiftly handled by conveyer.

Refueled and reloaded without benefit of the many ramp vehicles currently in use, the plane would be ready for take-off in far less time than is now possible. Specifically, the airdock would: (1) Protect passengers from inclement weather; (2) sharply reduce time required to deliver baggage to deplaning passengers; (3) provide greater safety and comfort for ramp employees; (4) eliminate most of the vehicles now cluttering ramps; (5) substantially reduce airplane ground time at stations; and (6) greatly add to manpower efficiency in servicing aircraft.

According to United Air Lines, the airdock would be a two-level structure, located at one end of Loadair tracks built out to the taxi runway. The Loadair would have a single track for main landing wheels but separate nose-wheel tracks to fit all types of United's Mainliners—Convairs, DC-4s, DC-6s, DC-6Bs, and upcoming DC-7s which the company has on order.

The ground floor of the airdock would have three main sections—one for baggage claiming, one for cargo handling, and a third to house equipment to heat or cool cabins of waiting planes. Two conveyers extending in from the plane parking area would run through the cargo-handling section and end at the baggage counter. Delivery of luggage would be speeded by a steady inflow on conveyers, set in motion as soon as planes dock.

The plane parking ramp would be equipped with radiant

heating to keep its surface free of ice and snow. Underground pipes for water and sewage would terminate at plane-side. Two stands, flush with the surface of the ramp when not in use, would be elevated hydraulically to service planes with oil and fuel. Other outlets at convenient points would provide solvents, pneumatic air, and electric power.

The main part of the airdock's upper floor would be occupied by a waiting room at one end of a corridor through which all passengers would board or deplane. They would step directly in or out of planes. Rooms flanking the corridor would include an office, lavatories, and storage space for cabin supplies and vacuum-cleaner equipment. There also would be a section at which meals would be prepositioned for transfer aboard outgoing planes.

## Passenger-Belt Subway System

A WORKING model of the design for the world's first passenger conveyer system was shown recently in New York City to more than 600 city and state officials, businessmen, and transportation experts. The 15-ft model is a scale replica of the passenger conveyer-belt subway shuttle which has been proposed for New York City by Goodyear Tire & Rubber Company and Stephens-Adamson Manufacturing Company (see MECHANICAL ENGINEERING, October, 1952, pp. 826-827).

The model actually depicts operation of the proposed passenger conveyer system with moving loading and unloading platforms, deceleration and acceleration systems, main-line belts, turn-arounds, and "astradome" cars.

Plan and model grew out of a suggestion to Goodyear by Col. S. H. Bingham, Mem. ASME, chairman of New York City's board of transportation, that the present Grand Central-Times Square shuttle would lend itself to the installation of a passenger conveyer-belt system.

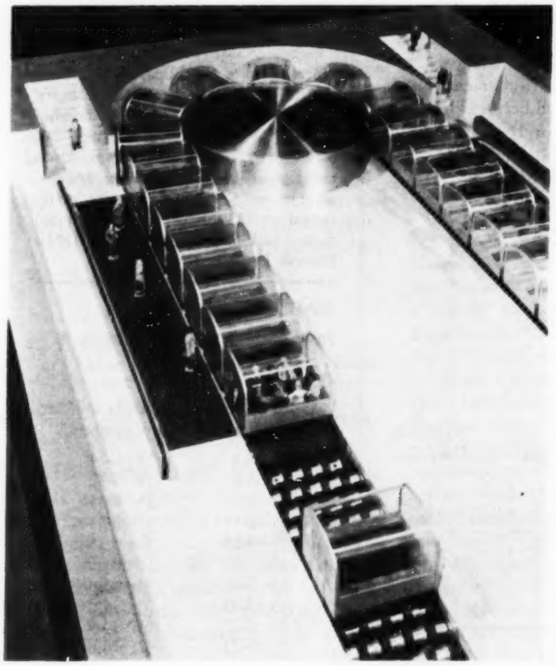


FIG. 11 CLOSE-UP OF WORKING MODEL OF PASSENGER CONVEYER-BELT SUBWAY SYSTEM FOR NEW YORK CITY

(Model figures standing on belt at left are moving at $1^1/_2$ mph, the same speed as the cars which they are about to enter. Fully loaded car is about to enter acceleration phase which is accomplished on a bank of pneumatic-tired wheels moving at increasing speeds up to 15 mph.)

Goodyear engineers, in co-operation with engineers of Stephens-Adamson, designed a "continuous-flow transit system" using moving loading and unloading platforms and small, closely spaced passenger cars riding on an endless track of rubber conveyer belts and pneumatic-tired banks of powered wheels for speeding up and slowing down the cars.

Passengers at either end of the conveyer-belt subway walk directly onto the loading platform, a moving belt, nine feet wide. Alongside the loading platform, and moving at the same speed is a continuous stream of small passenger cars with seats. Nineteen cars, each seating 14 passengers, pass the loading platform each minute. Capacity of the system may be increased by using larger cars and speeding up the rate of flow along the loading platform.

Leaving the loading area, the cars move over a series of pneumatic-tired accelerating rollers. Each row of wheels is moving at a speed slightly greater than the previous row, so that the car is uniformly accelerated to 15 mph from the loading speed of $1^1/_2$ mph. The cars are slowed at the other end of the system by a similar method. Passengers step out of the cars to the unloading platform, a moving belt similar to the loading platform, and walk off the end.

Capacity of the conveyer-belt subway shuttle will be 16,000 persons an hour in each direction or 32,000 for the system. This compares with peak-load capacity of 23,000 passengers per hour in the present shuttle.

Installation and operation costs of the Goodyear-Stephens-Adamson passenger conveyer-belt subway are much less than those for conventional subway equipment. Installed in existing tunnels, the cost of the high-speed conveyer equipment is estimated at less than 60 per cent of the cost for conventional subway equipment.

Operations and maintenance costs of the conveyer subway are estimated at 40 per cent of similar expenditures on the present shuttle.

Over-all cost of the Grand Central-Times Square conveyer-belt system, including rehabilitation of the tunnels under 42nd Street, is estimated at \$3,800,000. This compares with an estimated \$5,500,000 that would be required to modernize the present shuttle operation.

## Coal-Burning Gas Turbine

DEVELOPMENT of a coal-burning gas turbine has reached the stage that intensive work on possible commercial applications, particularly for locomotives, is to get under way, according to a joint announcement by President Roy B. White of the Baltimore and Ohio Railroad, who is chairman of the Locomotive Development Committee of Bituminous Coal Research, Inc., and Perry T. Egbert, president, American Locomotive Company.

The two executives said that a contract had been signed between Bituminous Coal Research, Inc., and the American Locomotive Company. Under this agreement, Alco will carry on development of the turbine for commercial applications and design a chassis for locomotive use. The joint program of continued research and development will be carried out by BCR's Locomotive Development Committee and the locomotive-building firm.

Researchers for the Locomotive Development Committee, representing a group of nine major coal-carrying railroads and five of the nation's largest coal companies, have carried on the coal-burning gas-turbine-research program since 1945.

# ASME TECHNICAL DIGEST

*Substance in Brief of Papers Presented at ASME Meetings*

## *Gas Turbine Power*

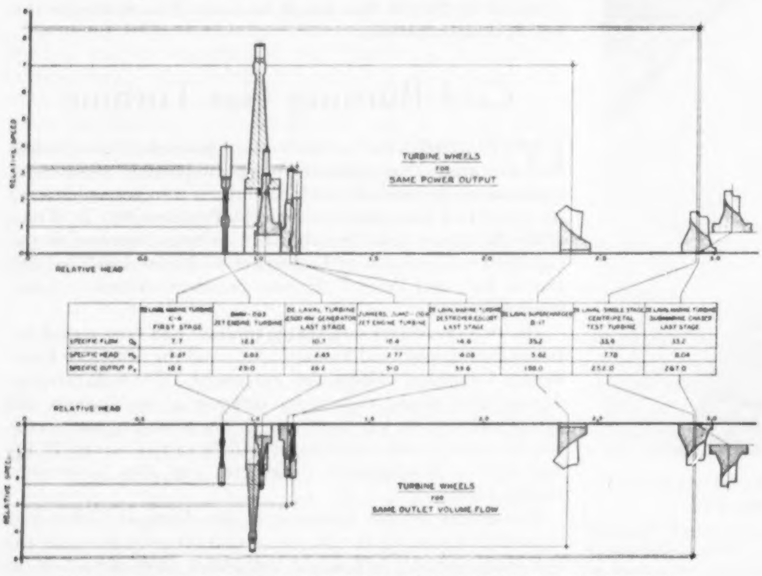
**The Elastic-Fluid Centripetal Turbine for High Specific Outputs,** by Rudolph Birmann, Mem. ASME, De Laval Steam Turbine Company, Trenton, N. J. 1953 ASME Spring Meeting paper No. **53—S-16** (mimeographed).

IN the water-turbine field, the centripetal turbine—known as the Francis turbine—has been widely used for the past 100 years. In the field of turbines for elastic fluids, however, no counterpart of the Francis water turbine was conceived until 1928. At that time the De Laval Steam Turbine Company undertook a study dealing with the possibility of such an application, and soon thereafter constructed two different experimental units.

From the beginning it was realized that for any given enthalpy drop a centripetal turbine can be built for low or high specific speeds. The low-specific-speed version is suitable for relatively low rpm and small flow-operating conditions for which an axial-flow turbine can readily be designed and quite often used to advantage. The high-specific-speed version of the centripetal turbine is capable of handling (for the same given enthalpy drop) larger flows than the axial-flow turbine, and of operating at higher rpm and with lower stresses. Even the early theoretical analysis of 1928, the findings of which were later confirmed, clearly brought out the aforementioned advantages of the high-specific-speed version of the centripetal turbine. This led to the concentration of the De Laval development effort on this version.

This paper constitutes a review of the various aspects of this development. Because of the unique advantages of the high-specific-speed version, the paper does not go into the much less useful low-specific-speed type, better known because it has recently been given some attention in technical papers.

In this paper it is shown, by the presentation of drawings, photographs, test results, and numerical examples, that the centripetal turbines can be designed to handle larger flows and higher enthalpy drops at higher rpm with better efficiency and lower stresses than the axial-flow turbine. Because very high specific outputs are thus made possible, this type




NONDIMENSIONAL CLASSIFICATION OF VARIOUS DESIGNS OF AXIAL-FLOW AND CENTRIPETAL-TURBINE WHEELS

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permits the solution of design problems which cannot be solved by the axial-flow wheel.

**Ceramic-Coated Low Alloys for Jet-Engine Hot Parts,** by J. V. Long, Solar Aircraft Company, San Diego, Calif. 1953 ASME Spring Meeting paper No. **53—S-35** (mimeographed).

ONE of the most logical and effective methods of conserving critical and strategic elements, without curtailing production schedules, is to substitute ceramic-coated lower alloys for the alloys now used.

Solar Aircraft first became interested in protecting low alloys for manifolds during the early days of the last war. All known methods of surface protection were investigated and it was concluded that ceramics might be the answer. A study of modified porcelains was initiated and it was found they might be satisfactory up to temperatures of 1000 F. However, their thickness of application would not fit into the close tolerances demanded, nor did they have the required thermal and mechanical shock resistance.

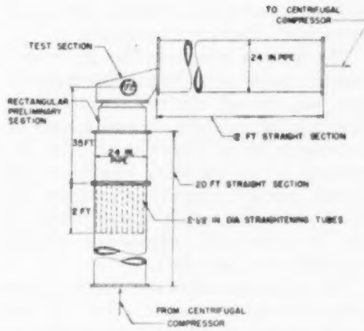
This information started the research to find some answers. These were in the form of unique high-temperature ceramic coatings characterized by extreme thinness, toughness, and exceptional adherence.

During this work excellent protective coatings for many alloys were formulated. It was also learned that a coating was not the whole answer to substitute materials. Much co-operation is required between designers, metallurgists, fabricators, and ceramists to accomplish the job.

**An Interferometric Study of the Boundary Layer on a Turbine Nozzle Blade,** by Charles R. Faulders, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1953 ASME Spring Meeting paper No. **53—S-36** (mimeographed).

THE boundary layer on a turbine nozzle blade was investigated with an optical interferometer over a range of Reynolds numbers and subsonic downstream Mach numbers. The ratio of laminar boundary-layer thickness to distance downstream from the minimum pressure point on the suction side of the blade was found to be essentially a unique function of a length Reynolds number based on this distance.

Thickness critical Reynolds numbers for transition increased, with throat Reynolds number, from 3000 to 9000 on the suction side and from 1200 to 3100 on the pressure side. A laminar velocity




SCHEMATIC DIAGRAM OF TEST SECTION INSTALLATION IN WIND TUNNEL

profile was computed from a density profile measured at a point of zero pressure gradient, and satisfactory agreement with theoretical profiles was obtained.

**Possible Range of Design of One-Spool Turbojet Engines Within Specified Turbine-Design Limits,** by Robert E. English and Richard H. Cavicchi, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. **53—S-33** (mimeographed).

THIS design-point analysis of turbines shows quantitatively how high the air flow per unit turbine-tip area and compressor pressure ratio can be within certain specified design limits on one and two-stage turbines. In addition, the direction of changes in engine design in order to achieve even higher values is indicated.

The extent to which both the air flow per unit turbine-tip area and compressor ratio increase as blade-row entrance Mach number is raised indicates the desirability of being able to design for high values of Mach number. Increasing the exit axial-velocity ratio from 0.5 to 0.7 results in rises in both air flow per unit turbine-tip area and compressor pressure ratio although the gains are greater for one-stage turbines than for two-stage turbines. Use of both high turbine blade-tip speeds and exit hub-tip radius ratio as low as 0.5 also produces increases in air flow per unit turbine-tip area and compressor pressure ratio. In particular, two-stage turbines appear to be capable of driving one-spool compressors of very high pressure ratio unless the air flow per unit turbine-tip area is pushed too high. If high air flow per unit turbine-tip area is to be exploited at the expense of compressor pressure ratio, values of hub-tip radius ratio at the turbine exit lower than 0.5 should, in some cases, be investigated. Raising the turbine blade-tip speed and lowering the hub-tip radius ratio would, however, present more severe mechanical-design problems. The turbine stresses would rise and the space available for attaching rotor blades to the turbine disks would diminish with reduced hub-tip radius ratio. In addition, if high turbine blade-tip speeds are to be used, either the turbine-tip diameter must be made greater than the compressor diameter or the compressor must be designed for high blade-tip speeds.

**The Free-Piston Type of Gas-Turbine Plant and Applications,** by J. J. McMullen, Bureau of Ships, Navy Department, Washington, D. C., and Robert P. Ramsey, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1953 ASME Spring Meeting paper No. **53—S-13** (mimeographed).

IN this paper the latent possibilities in heavy-duty free-piston machinery are discussed. The cycle promises diesel efficiency from a simple low-temperature gas turbine having low first costs. Many features are described in the paper. Cooper-Bessemer has built a test plant and is now investigating its operating characteristics. No conclusions have been announced. Economic evaluations are being made requiring additional field work which includes an examination of the general acceptance by engineering and operating people who will ultimately decide the actual utility. Detailed cost studies of complete plants, including careful estimates of the machinery, have been made for electric-power generation, pipe-line pumping, and marine installations. Some of these have been made available for use in this paper.

The Cooper-Bessemer investigation of a heavy-duty free-piston turbopower plant has been followed with interest by the U. S. Navy Bureau of Ships because of its possible future application to all types of auxiliary vessels such as cargo ships, troop transports, tankers, and others.

Free-piston machinery may be applied to wide ranges of weights and outputs, some of which have only recently been undertaken. However, these findings indicate a very definite suitability to many heavy-duty applications.

In this case the free-piston machine weighs about 30 lb per hp normally aspirated and will weigh less than 20 lb per hp when supercharged. It is designed structurally as heavy as a 100-lb per hp motorship diesel.

The paper has three objectives:

1 To describe the potential effectiveness of heavy-duty free-piston machinery.

2 To discuss an investigation of a heavy-duty free-piston turbo prime mover.

3 To make a realistic appraisal of free-piston turbine power in three heavy-duty service applications—an electric-power generating station, a pipe-line pumping station, and a cargo vessel.

**Performance of Free-Piston Gas Generators,** by J. J. McMullen, Bureau of Ships, Department of the Navy, Washington, D. C., and Warren G. Payne, U. S. Naval Engineering Experiment Station, Annapolis, Md. 1953 ASME Spring Meeting paper No. **53—S-18** (mimeographed).

THE free-piston gas generator-turbine power plant combines the high thermal efficiency of the diesel-engine combustion cycle with the simplicity and flexibility of the turbine power take-off. It consists of a gas generator producing high-temperature and pressure gas which is used to drive a turbine. The gas generator has two opposing pistons in a single-power cylinder. These pistons compress their own air for scavenging and charging the power cylinder. They also store the energy required to halt their outward movement and return them for the next compression stroke. Combustion proceeds on the two-stroke-diesel cycle and power is produced by the exhaust gas which drives the turbine. The crankshaft, connecting rods, and bearings of the diesel engine are eliminated.

In comparison to a gas-turbine power plant, the free-piston gas generator supplants the compressor, compressor turbine, combustion chamber, and heat exchanger. Ducting is much less.

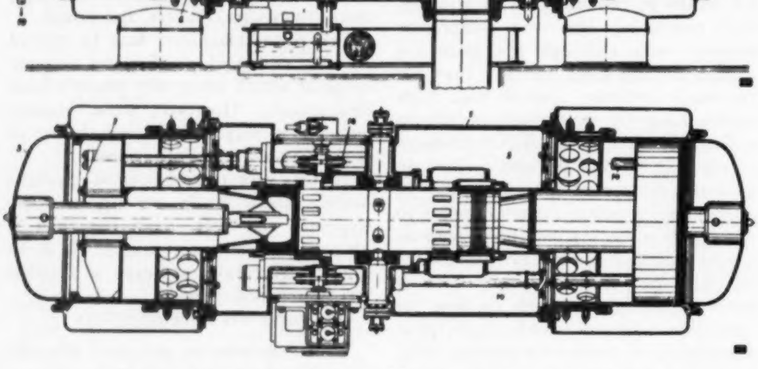
The use of a free-piston gas generator-turbine combination for producing power has long passed the theoretical stage. Test data are available on two designs of free-piston units which have been developed to an operating condition and which provide factual information for their evaluation. A third unit is now in the test phase and information will be available at a later date.

The paper notes that the free-piston gas generator-turbine power plant has already shown its commercial suitability and acceptability by the variety of installations made with the SIGMA units in France. Developments in this country have shown that several concepts of the same principle of operation can be perfected. Operational data have shown that the thermal efficiency of modern diesel engines can be surpassed with a power plant of no greater bulk or weight, fewer working parts, and reduced cost and time of construction. The free-piston engine has shown that it has many peculiar advantages, such as absence of mechanical vibration. It provides an independent high-speed drive well-suited to various types of applications.

The free-piston unit as presently available in this country is the result of comparatively little development. A total of only seven gas generators has been constructed. Two models now appear ready for commercial exploitation. These models have not reached the stage of perfection which will be possible with continued development but they are commercially competitive.

One line of development certain to be continued, especially for uses where low specific weight and mass are required, is supercharging of the power cylinder. Outputs approaching twice the present output with little increase in severity of operation will be obtained. The weight of the power plant will be decreased accordingly. Another line of development is after-burning. This possibility is attractive because the exhaust gases from the gas generator contain approximately 75 per cent of the original oxygen, and by after-burning the power output can be increased about 30 per cent with only an approximate 10 per cent increase in specific fuel consumption. When one considers that this increase in power is obtained by the addition of a comparatively simple combustion chamber of low weight and yet, maintaining the same operating conditions in the gas generator, the possibilities are apparent.

A parallel line of development will be perfection of heavy-duty units for installation where low initial cost, easy maintenance, economy of operation, and long life and reliability are the more important factors. Low exhaust pressures and temperatures will reduce cost and increase life of the turbine. The power plants will still have a specific weight and mass superior to that of comparable diesel-power plants.



CROSS SECTION OF SIGMA MODEL GS-34 FREE-PISTON GAS GENERATOR

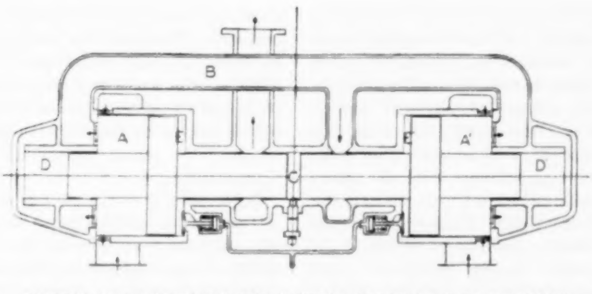
(1 Engine case, 2 compressor cylinder, 3 dished ends, 4 motor cylinder, 5 scavenge air receiver, 6 suction valve, 7 delivery valve, 8 balance pipe, 9 coolant inlet, 10 coolant outlet, 11 gland, 12 starter, 13 stabilizer, 14 synchronizing rod.)

**The Development of High-Output Free-Piston Gas Generators,** by Robert A. Lasley, Mem. ASME, Baldwin-Lima-Hamilton Corporation, Hamilton, Ohio, and Frank M. Lewis, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1953 ASME Spring Meeting paper No. **53—S-34** (mimeographed).

THE development of free-piston gas generators suitable for Naval propulsion purposes was started in 1943 at the Baldwin-Lima-Hamilton Corporation, then the General Machinery Corporation, under a contract with the U. S. Navy Department.

For certain Naval propulsion purposes the free-piston gas generator-gas turbine or "gasifier-turbine" power plant has potential advantages.

The developments at Baldwin-Lima-Hamilton have been concerned exclusively with gasifiers of high specific output, suitable for Naval propulsion, or other applications which require light-weight machines.




GASIFIER WITH OUTWARD COMPRESSION, OUTER BOUNCE CYLINDER

The weight and volume of a gasifier-turbine plant of a given total output power is largely fixed by the weight and volume of the gasifier part of the plant. This is influenced by the following factors: The size and number of the gasifier units used for a given total power; the arrangement of the parts of the gasifier; the pressure and temperature of the cycle; the piston speed of the gasifier; and the design as regards material used, thickness of stressed parts, and other similar factors.

Of the gasifiers constructed by Baldwin-Lima-Hamilton, the Model A is of 7-in-bore power cylinder, 21-in-bore compressor cylinder × 10-in. full power stroke and the Model B of $8^1/_4$-in-bore power cylinder × 23-in-bore compressor cylinder × 11-in. full power stroke.

All arrangements utilize a pair of opposed pistons connected by some type of synchronizing mechanism to insure their operation in exactly opposite phase. This opposed-piston arrangement gives a balance of inertia forces, so that any vibratory reactions between the gasifier and its foundations are limited to forces produced by the pulsating flow of the discharge and scavenge gases.

# *Rubber and Plastics*

**Polytetrafluoroethylene—Its Properties and Uses,** by L. W. Cornell, Minnesota Mining & Manufacturing Company, St. Paul, Minn. 1953 ASME Spring Meeting paper No. **53—S-23** (mineographed).

TEFLON is the trade name for a comparatively new polymeric resin with unique properties, which is composed of tetrafluoroethylene, $C_2F_4$. The basic polymer is made and sold only by the du Pont Company, but a number of other companies process and sell Teflon in different forms for the ultimate consumer. Because there is only one manufacturer of this material at present it will be called by its trade name.

Teflon is an excellent electrical insulator for many purposes, particularly where high temperature conditions must be met. It may be used at temperatures as high as 500 F, in continuous service, and withstands intermittent exposure to 600 F. It also retains its flexibility and electrical properties as low as —100 F. There is increasing demand for Teflon insulated wire and cable in jet aircraft, for example. Guided missiles are another application where Teflon is being used, again because of the temperature range encountered.

Chemically, Teflon is about as inert as glass, within its useful temperature range. It is attacked by molten alkali metals (sodium or potassium) and by fluorine and chlorine trifluoride, both at high temperatures and pressures. Other than these specific chemicals, published literature indicates that nothing has any effect on Teflon. This makes it ideal as a gasket material and liner in equipment in which high-temperature, highly corrosive chemicals must be handled. Since there is no known solvent for Teflon, it can be used in contact with any ordinary solvent without effect.

Its mechanical properties are very stable up to 500 F. For example, molded bars held at 480 F for one month show a loss of only 1 per cent in tensile strength. At 570 F the loss is 10 to 20 per cent. In addition to its high-temperature resistance it is serviceable to —100 F. In fact, instances of its use at temperatures as low as —320 F have been reported.

The plastic absorbs no water at all, and therefore its electrical, physical, mechanical, and chemical properties are unaffected by soaking in water, or by exposure to high-humidity atmosphere.

One of Teflon's most interesting properties is its nonadhesiveness or slipperiness. This property has proved to be useful in many applications in the industrial field. For example, one large coating machine was giving a great deal of trouble with dirtying of idler rolls in the oven on a certain coating job which was performed at intervals. The problem was solved by spiral-wrapping wide Teflon film around the roll, taping it down at each end of the roll. When the operation was finished, the Teflon film was unwound and stored until it was needed again.

**Unplasticized Polyvinyl Chloride—A Corrosion-Resistant Structural Material,** by George S. Laaff, The Bolta Company, Lawrence, Mass. 1953 ASME Spring Meeting paper No. **53—S-24** (mimeographed).

UNPLASTICIZED polyvinyl chloride (PVC) today is a purely theoretical phenomenon. The term "unplasticized" PVC is used in this paper, however, as the term "rigid" PVC would open the entire field to the use of so-called processing aids and other types of modifiers without violating the basic terminology. The word unplasticized PVC is much more specific and restricting. In general, commercial unplasticized PVC may be considered as a compound of substantially pure polyvinyl chloride resin in which only the minimum amount of stabilizer for processing stability is used. The optimum physical and chemical properties are obtained in unplasticized PVC.

Rigid PVC is the term applied to compounds which are substantially resin and stabilizer, to which modifying resins, fillers, and often small amounts of plasticizers have been added. These modifications are usually made to improve processing properties. The processing aids or modifiers, added to the pure PVC resin, whether in polymerization or in subsequent compounding, will reduce the intermolecular attractive forces of the polyvinyl chloride and as such will change the physical and chemical properties from those of the pure resin. Rigid PVC will usually have lower physical and chemical properties than unplasticized polyvinyl chloride in corrosion-resistant structural applications. It can generally be said that resistance decreases with heat especially above 160 F.

It should be noted that the resistance of unplasticized PVC is nonexistent toward some organics and doubtful toward others. Most aldehydes, ketones, esters, ethers, and chlorinated hydrocarbons will attack unplasticized PVC readily. Other organics cause less severe swelling but subsequent weakening. Long-chain hydrocarbons and high hydroxyl-content compounds have little or no effect on the unplasticized polyvinyl chloride.

Because it is difficult to duplicate actual conditions of some specific process, especially if borderline resistance may be expected, samples of unplasti-

cized PVC should be placed in the corrosive media for long-term contact.

Because of its tendency to creep under sustained load, unplasticized PVC will support a load equal to its normally reported tensile strength for only a matter of minutes. The permanent load which can be supported at 70 to 75 F is approximately 30 to 40 per cent of this value.

Notch brittleness is another important physical characteristic which must be considered. Sharply angled joints and deep grooves should be avoided. In some cases unusually heavy cross section or other structural deviations will have to be used in order to guard against notch weakness. The engineer must always bear in mind the thermoplastic nature of the material and must design accordingly.

Upon logically considering the excellent corrosion-resistance and fabrication possibilities of unplasticized PVC, however, it will be realized that there are very many uses to which it may be applied most advantageously.

Unplasticized PVC is available for fabrication in the form of sheets from $^1/_{32}$ through 1 in. and as tubing and pipe from $^1/_4$ through 6 in. It can also be obtained as bar stock, both round and hexagonal, as solid blocks for heavy cross sections, and also in the form of welding rod. Molding compounds are available for transfer molding into standard pipe fittings such as 45 and 90-deg elbows, couplings, tees, unions, caps, plugs, flanges, and other types of joints.

These shapes may be fabricated into many structures where chemical inertness is of prime importance. Fume hoods and ducts in combination with fans and blowers are being made of unplasticized PVC.

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**Progress in Manufacturing Methods in the Molded-Rubber-Products Industry,** by J. H. Gerstenmaier and F. J. Fetter, Goodyear Tire and Rubber Company, St. Marys, Ohio. 1953 ASME Spring Meeting paper No. **53—S-32** (mimeographed).

THE rapid development and expansion of the molded-rubber-products industry is plainly evident when today's products are compared with molded products produced before World War II. Ability of molded rubber or rubber and metal products to dampen vibration, seal, cushion, and resist abrasion, coupled with a growing knowledge of its adaptability has greatly expanded its use. However, the production application was made possible on a large volume, economical basis by the simultaneous development of the rubber-manufacturing processes, controls, and equipment.

Today, the typical plant devoted to the manufacture of molded-rubber products must be capable of producing parts to very close dimensional tolerances, of controlling compound physical properties to an exacting degree, and of inspecting and testing parts to assure they meet functional requirements for the many and varied industrial, transportation, and appliance fields. Electronically-controlled cutters, carefully controlled cementing and drying machines, press cycles automatically regulated, higher vulcanizing temperatures and molding pressures, cold temperature tumbling for flash removal, and conveyerized load-deflection testing machines all have aided in this progress toward more proficient and exacting manufacturing techniques.

As a result, mold-rubber manufacturing has developed as an important division of the rubber industry. Industrial molded-rubber products are no longer considered side-line products. Manufacturing processes have developed which are applicable only to molded products and are even further specialized to apply only to certain types of products in the industry. This paper shows the progress in manufacturing techniques that has lead the industry away from the general classification of miscellaneous mechanical rubber goods to the highly specialized category of industrial-molded product manufacturing.

Basic mixing of the rubber compound is excluded from this paper because the manufacturing techniques here closely follow those used for any rubber-manufacturing operation. A plant devoted to the manufacture of molded-rubber products probably will have one or more banbury mixers, plus other basic machinery with variations in size or supplementary equipment, depending upon the quantity and type of rubber compound usually produced. Specialized operations begin when the mixed compound is being prepared to the right shape and size for molding. The following steps through the factor are discussed: uncured rubber preparation, metal preparation, mold design and curing, finishing processes, and inspection and testing.

# *Machine Design*

**A Proposed Standard Design for General Industrial Coarse-Pitch Cylindrical Worm Gearing,** by F. G. East, Mem. ASME, Hamilton Gear & Machine Company, Ltd., Toronto, Ont., Can. 1953 ASME Spring Meeting paper No. **53—S-5** (mimeographed).

WORM gearing, although one of the oldest types of gearing, is the one remaining type for which no recognized standard of design for the general industrial coarse-pitch range exists on this continent.

There is an excellent ASME-ASA-AGMA standard covering the fine-pitch range but there is nothing to complement this standard in the general industrial coarse-pitch range. Lacking standard, manufacturers of worm gears and worm-gear reduction units have individually set up their own standards for tooth proportions, pressure angle, worm diameters, gear faces, etc. It is believed a standard recognized by the industry for all future designs is long overdue. This would be of inestimable assistance to engineers and designers of equipment. When a limited number of gear sets are required, the cost of tooling is important. If the design can be modified somewhat to suit existing facilities, it is advisable to consult one or more manufacturers to see what tooling is available to produce gears close to desired sizes, rather than design strictly to a standard. However, the tentative design to submit to the manufacturer should be based on some recognized standard. For a new design that is to be made in sufficient volume to warrant the purchase of tooling, adherence to this standard is preferable and strongly recommended.

This paper suggests a method of standardizing general industrial coarse-pitch cylindrical worm-gear drives, particularly the worm diameter and tooth proportions, to eliminate the present state of affairs where no recognized standard exists. The suggestions contained in this paper do not insist on a single worm diameter for each pitch or center distance but rather a limited group of worms that will cover the range of good design.

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**Natural Frequency of a Nonlinear System Subjected to a Nonmassive Load,** by C. E. Crede, Mem. ASME, The Barry Corporation, Watertown, Mass. 1953 ASME Spring Meeting paper No. **53—S-10** (mimeographed; to be published in Trans. ASME).

IN a vibration isolator whose force-deflection curve exhibits nonlinear characteristics, the stiffness of the isolator is a function of its deflection, or of the load which it supports. Many isolators that embody resilient material loaded in compression, exhibit gradual increase in stiffness when the deflection increases. Large deflections may result from the dead-weight load of the supported equipment; from an external force, such as belt pull in belt-driven machinery;

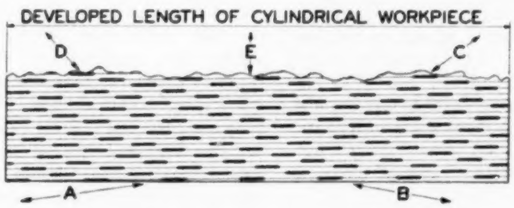
or from the inertia forces derived from sustained acceleration, such as that embodied in the take-off of a rocket or missile. In some of these applications, the force applied to the isolator is greater than the dead-weight of the supported load.

This paper discusses a single-degree-of-freedom system with nonlinear elasticity such that the stiffness increases as the deflection increases. This stiffness increase, without a change in the mass, effects an increase in natural frequency. Graphical means are presented to evaluate the increase in natural frequency when the support for the system experiences a sustained constant acceleration.

**Some Vibration Effects on Surfaces Produced by Turret Lathes,** by P. T. Eisele, Jun. ASME, and R. F. Griffin, The Warner & Swasey Company, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. **53—S-12** (mimeographed; to be published in Trans. ASME).

ONE of the problems confronting machine-tool builders is to produce a satisfactory finish on the workpiece. In addition to the ordinary toolmarks produced on lathe workpieces, other markings resulting from vibration are often present. These other markings can generally be divided into two groups. The first, tool "chatter," is due to a relatively high-frequency vibration in which the cutting edge of the tool oscillates in a direction approximately tangential to the work surface. The second type, a spiral finish or "barber-pole effect," is generally due to a relatively low-frequency vibration in which it is assumed that the cutting edge of the tool moves approximately radially in and out from the work surface. A spiral pattern may also be produced by tool chatter.

This paper deals particularly with the nature of the spiral finish produced by a turret lathe under some low-frequency-vibration conditions. Conditions causing this type of surface are shown together with a theoretical analysis. Some data on vibration magnitude and surface roughness are given. A discussion is included on the degree of balance obtained in commercial motors and its effect on surface finish. Some of the conclusions reached are as follows: Spiral roughness appears to be independent of tool radius within a limited range; the spiral sensitivity of a turret lathe is a better guide for setting manufacturing balance limits on rotating parts than is the vibration amplitude; and commercial motors, as received, are often unsuitable for turret-lathe use.




| | STARTS | HAND | ORDER | APPROXIMATE FREQUENCY |
|---|---|---|---|---|
| A - | 7 | R.H. | 1ST | 300 x 7 = 2100 RPM (HIGH) |
| B - | 6 | L.H. | 1ST | 300 x 6 = 1800 RPM (LOW) |
| C - | 13 | R.H. | 2ND | 300 x 13/2 = 1950 RPM (HIGH) |
| D - | 19 | L.H. | 3RD | 300 x 19/3 = 1900 RPM (LOW) |
| E - | 32 | — | 5TH | 300 x 32/5 = 1920 RPM (EXACT) |

WORKPIECE SPEED - 300 RPM DISTURBING FREQUENCY - 1920 RPM

SCHEMATIC DIAGRAM OF TYPICAL MULTIPLE-ORDER SPIRAL

**Bearing Design Using Concentric Journal Theory,** by R. R. Slaymaker, Mem. ASME, Case Institute of Technology, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. **53—S-11** (mimeographed).

THIS paper discusses a simple analysis which has proved useful in setting up limits between which a bearing will usually operate satisfactorily. Two actual case studies are given to illustrate the method.

A large part of plain-bearing-lubrication analysis has been devoted to the determination of oil-film thickness on the assumption that oil-film thickness is the limiting factor in design. It is perfectly true that load, speed, viscosity, and clearance can always be combined to produce an oil film so thin that the bearing is in a critical condition and pure seizure will result. However, experience, particularly in the field of internal-combustion engines, indicates that pure seizure is rarely encountered. Misalignment, excessive deflection, dirt in the oil or behind the bearing lining, fatigue of the bearing metal, and corrosion are among the usual causes of failure. Most of these troubles have little to do with hydrodynamic theory which means that much of the time spent in computations, which disregard these matters, is hardly justified.

Usually a bearing will operate satisfactorily if it runs cool enough. However, the term cool enough is rather ambiguous since it depends on the application. A pedestal-type partial bearing with a thick-wall babbitt lining, for example, should have an operating temperature much lower than a thin-wall steel-backed automobile connecting-rod bearing. In both cases, however, temperature trends may be predicted by assuming the journal to operate concentric with the bearing. Safe maximum temperatures are, of course, set as a result of experience with existing bearings computed in the same way. Some fundamental equations based on concentric operation are developed in this paper.

It is concluded that bearings will usually operate satisfactorily over a range of loads, speeds, oil viscosities, and clearances so that the designer has some latitude in his specifications. It is generally more important that the designer know whether a certain change will make matters better or worse than it is for him to calculate any numerical quantities definitely. Not always are operating conditions such that all variables can be controlled or anticipated and not always does the designer have the facility of a bearing expert. When this is so, a simple analysis based on assumed concentric operation should be of value in arriving at conclusions which are within reason.

# *Metal Processing*

**A Plastic Flow Problem Arising in the Theory of Discontinuous Machining,** by E. H. Lee, Mem. ASME, Brown University, Providence, R. I. 1953 ASME Spring Meeting paper No. **53—S-22** (mimeographed).

IN this paper plastic flow is analyzed adjacent to the nose of the tool in the initial stages of the formation of a discontinuous chip segment. It is assumed on the basis of experimental evidence that fracture of the previous chip segment occurred across a plane through the cutting edge of the tool. The present solution applied only while the fracture surface is being deformed, before plastic flow spreads to the initial work surface. The solution demonstrates the influence of the plastic stress distribution in determining the chip-formation process. It shows that simple shear across a plane between two undeforming regions cannot satisfy stress conditions in typical cases.

It is shown that the inclination of the plane of equivalent simple shear is remarkably insensitive to the coefficient of friction at the tool face.

The variation to be expected due to spread of plastic flow to the initial work surface is briefly discussed. The choice between alternative types of slip-line fields which arise in certain cases is considered.

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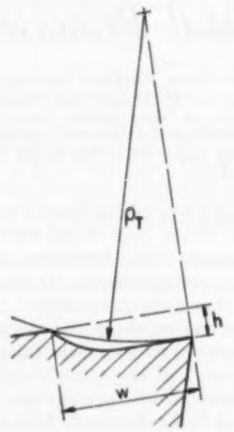
**Chip Breaking—A Study of Three-Dimensional Chip Flow,** by Erik K. Henriksen, Mem. ASME, Cornell University, Ithaca, New York. 1953 ASME Spring Meeting paper No. **53—S-9** (mimeographed).

The production of broken chips by means of a chip-breaker tool is studied by analysis and experiments.

The type of chip breaker discussed in this paper is essentially a step or shelf ground into the face of the tool parallel to the cutting edge. From the width $w$ and height $b$ of the chip breaker the radius $\rho_T$ of the inscribed circle is determined by

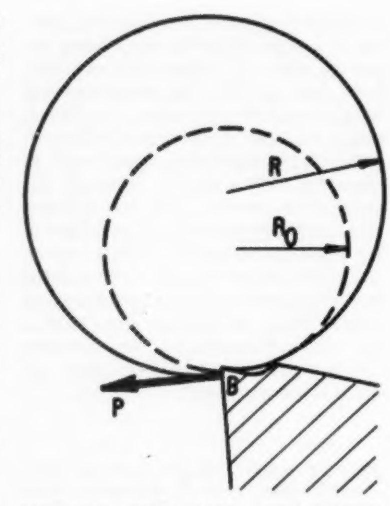
$$\rho_T = \frac{1}{2}\left(\frac{w^2}{b} \neq b\right).$$

Under satisfactory operating conditions the chip undergoes severe plastic deformation and leaves the chip breaker with a definite curl of a radius $R_0$ slightly larger than $\rho_T$. It is still unbroken but when it eventually meets the front of the tool or another obstacle a pressure $P$ builds up, the chip curl expands rapidly, and the chip breaks. The cycle repeats itself periodically.




ELEMENTS OF CHIP BREAKER

Analysis and observations show that the process, as described, depends on chip thickness and direction of chip flow as affected by cutting conditions. Chip




CHIP CURL WITH LARGE DEFORMATION BEFORE BRE'KING

thickness is essentially controlled by feed, and variation of feed through a wide range produces a variety of chips, which can be classified into few characteristic types. Very thin chips do not break; very thick chips break into short lengths under violent load fluctuations on the tool, resulting in frequent tool damage. Chips broken into satisfactory lengths are obtained at intermediate feeds, and the relationship between chip-breaker dimensions, as defined by $\rho_T$ (called chip-flow circle radius) and feed range for satisfactory operation (chip-breaking feed CBF) is illustrated by parabolalike curves. The individual values of $w$ and $b$, taken separately, are insignificant.

Depth of cut (more precisely depth of cut divided by nose radius of tool) controls the direction of chip flow across the tool face and, therefore, it affects the direction in which the chip strikes the chip breaker. This, in turn, modifies the feed for satisfactory chip breaking. The ultimate effect on the chip-breaking process can be illustrated by hyperbola-like curves for the relationship between depth of cut and CBF. Close agreement was found between analytical and experimental results.

Experimental work at Cornell University was sponsored by National Machine Tool Builders' Association.

# *Management*

**Selection and Training of Engineers,** by John Gammell, Assoc. Mem., Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1953 ASME Management Division Conference paper No. **53—MGT-8** (mimeographed).

THE problem of the recruiter and trainer is, in addition to persuading the few obviously capable people to come with his company, to keenly appraise those available to him, and perhaps, select someone whom other recruiters might reject. Then, with skillful and patient training, bring that man to a point of high usefulness.

According to the paper there are three checks that will aid the recruiter in deciding whether a potential employee is acceptable—a man's grades, activities, and personality. Two necessities in the training of an engineer are (1) overcoming any awkwardness in writing and speaking and (2) inculcating in him the fact that commercial necessities and economics are important parts of what he does.

Most engineering executives regard selection and training as one of their most important activities, the paper states.

Great stress is now being put on this matter because competition is keen, starting salaries are high, and recruiting is difficult.

**The Current Status of Engineering Supervision,** by F. R. Benedict, Westinghouse Electric Corporation, Pittsburgh, Pa. 1953 ASME Management Division Conference paper No. **53—MGT-9** (mimeographed).

ENGINEERING supervision has the major portion of the load in applying and directing the technology that will enable business to meet its objectives. This paper discusses the problems of the supervisor in operating within the scope of his responsibilities and also the steps that the executive branch take to organize all levels of management so that the operations can meet the planned objectives.

Management must initiate plans that, when properly executed, will result in the best utilization of the personnel within the organization. A comprehensive management-development program is an essential part of long-term business planning. Four basic steps in management development are: (1) Organizational needs should be determined, (2) the business should analyze what it has, (3) the business should inventory its management resources, and (4) the business must activate a program of guided development.

The supervisor must, first of all, weld a number of individuals, comprising different levels of age training and experience, into an efficient operating group

and second, he must get the work out. Some major responsibilities of a supervisor are: Evaluating and applying engineering manpower effectively, preparing work schedules and assigning the work, evaluating current products and assisting in the selection of new products, and planning minor and major development on current products.

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**Developing Engineers Into Executives,** by Robert F. Pearse, The Harold F. Howard Company, Detroit, Mich. 1953 ASME Management Division Conference paper No. **53—MGT-6** (mimeographed).

THE great need for executives with engineering backgrounds in industry today has led to much activity in the field of appraising and developing engineers for executive positions. Preliminary studies indicate that in some firms, only about one out of three engineers have the long-range potentials for development to top jobs.

Engineers, as well as other technical specialists, are being evaluated for such potential through the medium of projective-personality techniques which reveal personality patterns making for success in top executive positions.

In general, engineers have certain qualities which tend to impede their success in executive positions, just as do other occupational groups. By evaluating these qualities through projective techniques, it is possible to point out areas that can be strengthened through development. Thus engineers aspiring to executive positions or already occupying such positions may work on their "development points" as well as enhance their strengths through understanding of themselves. Such development will assist them to reach maximum effectiveness as executives.

The paper takes up typical personality traits of engineers, techniques of appraisal and measurement, and gives some executive-development suggestions for engineers.

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**What Management Expects From the Engineer,** by H. B. Riehl, Mem. ASME, Proctor & Schwartz, Inc., Philadelphia, Pa. 1953 ASME Management Division Conference paper No. **53—MGT-7** (mimeographed).

MANAGEMENT, whether it be top management, middle management, or any level of management, is primarily concerned with the making of decisions to act. Decisions are only as good as the accuracy of the facts presented; therefore, management expects the engineer to find the facts and present them after clear and objective thinking, free of emotion, without bias or evasion, this paper states. Management also expects clear and objective thinking in the engineer's relations with the so-called nontechnical departments of the business, such as cost analysis, sales analysis, expansion-program studies, and other industrial problems.

Management expects leadership from the engineer wherever he may be placed in the management team. It is only through leadership in all levels of management that management's objectives, policies, and plans may be made clear to all concerned.

Management expects the engineer to have ideas—ideas as to product; ideas as to the production of the product with regard to quality and cost that will make it competitive in its field; ideas as to the proposed presentation of new methods and processes, and the treatment of personnel responsible to him so that innovations in plant operation will be received with open-mindedness rather than with an attitude of passive resistance or open revolt.

Management expects the engineer to strive for development of mature and sound judgment. Without it, clear and objective thinking is difficult, constructive and inspiring leadership almost an impossibility, and certainly, ideas die when sound and mature judgment is not employed in evaluating them.

Above all, management expects the engineer to consider the over-all welfare of the company when making decisions at his level in the management structure.

Engineers usually find themselves placed in one of five major branches of engineering, namely: Sales, research, design, production, and industrial. From each of these divisions, management expects certain definite results.

## ASME Transactions for May, 1953

THE May, 1953, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains:

TECHNICAL PAPERS

Influence of Unheated Starting Sections on the Heat Transfer From a Cylinder to Gas Streams Parallel to the Axis, by William Tessin and Max Jakob. (52—F-21)

The Determination of Local Forced-Convection Coefficients for Spheres, by J. R. Cary. (52—F-29)

An Investigation of Heat Transfer From an Inclined Flat Plate in Free Convection, by B. R. Rich. (52—F-20)

Design of a Square-Root-Extracting, Force-Balance, Pneumatic Transmitter, Including Derivation of Formulas, by Arnold Goldberg. (52—F-41)

On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—III, Effect of Transverse Curvature, by A. Charnes, E. Saibel, and A. S. C. Ying. (52—F-37)

A Simple High-Speed Air Spinner for Centrifugal Testing of Small Mechanical Devices, by C. F. Bild and P. F. Vial. (52—F-34)

A Method of Obtaining Shear Stress-Strain Graphs by Interpretation of Moment-Twist Data, by P. H. Kaar. (52—F-31)

Corrosion and Erosion in the Synthetic-Fuels Demonstration Plant, by G. D. Gardner and J. T. Donovan. (52—F-28)

Pressure Operation of Large Pulverized-Coal-Fired Boilers on the American Gas and Electric System, by G. W. Bice and W. M. Yeknik. (52—F-32)

Radioactive Cutting Tools for Rapid Tool-Life Testing, by M. E. Merchant, Hans Ernst, and E. J. Krabacher.

The Influence of Higher Rake Angles on Performance in Milling, by J. H. Crawford and M. E. Merchant.

Vibrations in Knee-Type Horizontal Milling Machines, by Ivar Bendixen. (52—F-42)

Plastic Flow in a Lead Extrusion, by C. T. Yang and E. G. Thomsen. (52—F-18)

Chip Curl in Metal-Cutting Process Under Orthogonal Cutting Conditions, by R. S. Hahn. (52—F-16)

Deformation Work Absorbed by the Workpiece During Metal Cutting, by E. G. Thomsen, J. T. Lapsley, Jr., and R. C. Grassi. (52—F-24)

Stress Relaxation in Compression of Rubber and Synthetic-Rubber Vulcanizates Immersed in Oil, by J. R. Beatty and A. E. Juve.

Mechanical Properties of Glass-Cloth Plastic Laminates as Related to Direction of Stress and Construction of Laminate, by Fred Werren. (52—F-36)

Effect of Preloading and Fatigue on Mechanical Properties of Glass-Cloth Plastic Laminates, by A. D. Freas. (52—F-35)

Studies of Submergence Requirements of High-Specific-Speed Pumps, by H. W. Iversen.

Hydraulic Problems Encountered in Intake Structures of Vertical Wet-Pit Pumps and Methods Leading to Their Solution, by W. H. Fraser.

Ten Years' Progress in Management

Foreword, by L. M. Gilbreth.

Committee Personnel.

The Theory of Organization and Management, by R. T. Livingston.

Statistical Quality Control, by E. R. Ott.

Production Planning and Control, by E. H. MacNiece.

Work Simplification and Work Measurement, by D. B. Porter and Ercole Rosa, Jr.

Wage Incentives, by Phil Carroll.

Industrial-Plant Operation, by L. C. Morrow.

Purchasing, by S. F. Heinritz.

Marketing and Distribution, by Noble Hall.

Personnel Administration, by H. S. Hall.

Public Relations, by A. H. Forster.

Labor Relations, by G. M. Varga.

Cost Accounting, by J. A. Willard and W. P. Fiske.

Federal Administrative Management, by D. C. Stone.

International Co-Operation, by H. B. Maynard.

# ASME 1953 SPRING MEETING PREPRINTS

*Pamphlet copies of the following ASME Spring Meeting Papers are available from ASME Order Department, 29 West 39th St., New York 18, N. Y.*
*See page 494 for details*

| Paper No. | Title and Author |
|---|---|
| | **Fuels** |
| 53—S-2 | An Investigation of the Burning Characteristics of Pulverized Cinders, by J. M. Allen |
| 53—S-3 | The Smokescope—An Instrument for Estimating the Density of Smoke in Stack Effluent, by John P. Strange |
| 53—S-26 | Dust Emissions From Small Spreader-Stoker-Fired Boilers, by Elmer J. Boer and Charles W. Porterfield |
| 53—S-27 | Heavy-Duty Operation of Spreader Stokers, by M. W. Jones |
| 53—S-28 | Natural-Gas Peak-Load Problems in the Appalachian Area, by C. T. Konechy and B. J. Clarke |
| 53—S-47 | Mill Drying in Pulverizing High-Moisture Coals, by Wayne C. Rogers |
| | **Gas Turbine Power** |
| 53—S-13 | The Free-Piston Type of Gas-Turbine Plant and Applications, by J. J. McMullen and Robert P. Ramsey |
| 53—S-16 | The Elastic-Fluid Centripetal Turbine For High-Specific Outputs, by Rudolph Birmann |
| 53—S-18 | Performance of Free-Piston Gas Generators, by J. J. McMullen and Warren G. Payne |
| 53—S-33 | Possible Range of Design of One-Spool Turbojet Engines Within Specified Turbine-Design Limits, by Robert E. English and Richard H. Cavicchi |
| 53—S-34 | The Development of High-Output Free-Piston Gas Generators, by Robert A. Lasley and Frank M. Lewis |
| 53—S-35 | Ceramic-Coated Low Alloys for Jet-Engine Hot Parts, by J. V. Long |
| 53—S-36 | An Interferometric Study of the Boundary Layer on a Turbine Nozzle Blade, by Charles R. Faulders |
| 53—S-37 | Calculation of Transpiration-Cooled Gas-Turbine Blades, by John N. B. Livingood and E. R. G. Eckert |
| 53—S-38 | Some Theoretical Aspects of Centrifugal Turbines, by Richard L. Robinson |
| 53—S-39 | Thermodynamic Properties of Combustion Gases, by Gilbert S. Bahn |
| | **Heat Transfer** |
| 53—S-41 | Heat Transfer and Fluid Friction for Fully Developed Turbulent Flow of Air and Supercritical Water With Variable Fluid Properties, by R. G. Deissler |
| 53—S-42 | The Effect of Fin Geometry on the Performance of Heat-Exchanger Surfaces, by W. E. Hildino |
| 53—S-43 | New Aspects of Natural-Convection Heat Transfer, by Simon Ostrach |
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| 53—S-31 | The Unsteady-Flow Water Tunnel at the Massachusetts Institute of Technology, by James W. Dailey and Kenneth C. Deemer |
| 53—S-44 | Mixing and Equilibrium in Pipe Flow, by Willis H. Carrier and W. Stuart Misener |
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| 53—S-1 | An Analysis of the Dynamics of Hydraulic Servomotors Under Inertia Loads and the Application to Design, by Harold Gold, E. W. Otto, and V. L. Ransom |
| 53—S-17 | Phase-Plane Analysis—A General Method of Solution for Two-Position Process Control, by Donald P. Eckman |
| 53—S-25 | Dynamic Operation of a Force-Compensated Hydraulic Throttling Valve, by John L. Bower and Franz B. Tuteur |
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| 53—S-5 | A Proposed Standard Design for General-Industrial Coarse-Pitch Cylindrical Worm Gearing, by F. G. East |
| 53—S-10 | Natural Frequency of a Nonlinear System Subjected to a Nonmassive Load, by C. E. Crede |
| 53—S-11 | Bearing Design Using Concentric Journal Theory, by R. R. Slaymaker |
| 53—S-12 | Some Vibration Effects on Surfaces Produced by Turret Lathes, by P. T. Eisele and R. F. Griffin |
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| 53—S-46 | Investigation of Flame Temperatures in a Single-Cylinder Spark-Ignition Engine, by J. H. Potter and R. B. Dillaway |
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| 53—S-30 | The Solubility of Oxygen in Water, by L. M. Zoss, S. Suciu, and W. L. Sibbitt |
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| 53—S-9 | Chip-Breaking—A Study of Three-Dimensional Chip Flow, by E. K. Henriksen |
| 53—S-15 | On the Analysis of Cutting-Tool Temperatures, by E. G. Loewen and M. C. Shaw |
| 53—S-22 | A Plastic-Flow Problem Arising in the Theory of Discontinuous Machining, by E. H. Lee |
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| | **Rubber and Plastics** |
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| 53—S-24 | Unplasticized Polyvinyl Chloride—A Corrosion-Resistant Structural Material, by George S. Laaff |
| 53—S-32 | Progress in Manufacturing Methods in the Molded-Rubber Products Industry, by J. H. Gerstenmaier and F. J. Fetter |

# COMMENTS ON PAPERS

*Including Letters From Readers on Miscellaneous Subjects*

## Liability for Aircraft-Equipment Failure

COMMENT BY G. I. WHITEHEAD, JR.[1]

Manufacturer's liability for damage developing out of the use of its product by the public is an appropriate subject at this time for the aircraft industry and its insurers, and I should like briefly to develop the facts of two aircraft accidents involving air-line equipment which are closely related to what the author has had to say in his paper.[2] It would seem that the accidents are of particular interest on the subject of product safety when we consider that they occurred even though rigid compliance with detailed regulations, exhaustive inspections and testings are an essential part of production of a new product in aviation.

In general, there are four principal grounds for claims against the manufacturer when a scheduled airline accident occurs, subject, of course, to proof of legal liability: (1) The air carrier or its insurer's claim for the hull loss; (2) the air carrier's claim for loss of revenue and other consequential damage; (3) the wrongful death claims by personal representatives of deceased passengers' estates; and (4) actions by the air carrier against the manufacturer when the passenger-death actions have been limited to the air carrier as a defendant. All four of these grounds were involved in the two cases to be examined.

On October 24, 1947, a scheduled air line DC-6 was observed from the ground trailing smoke while in flight; the fire rapidly progressed, and the airplane crashed just short of an emergency landing strip at Bryce Canyon National Park, Utah, with fatal injuries to 47 passengers. After initial investigation and collection of wreckage, the cause of the accident remained a puzzle until the key to the matter was discovered about 3 weeks later when a DC-6 of another carrier was forced to make an emergency landing at Gallup, New Mexico, because of a fire in flight. The circumstances were similar in many respects to the Bryce Canyon accident, with the fortunate exception that the ship was landed safely, passengers and crew were evacuated, and the aircraft remained intact so that careful inspection could be made. The probable cause of both accidents was determined to be overflow of gasoline from the No. 3 alternative tank vent into the cabin heater-combustion air intake scoop.

Using hindsight after the cause of the accident had become known, people in and out of the aircraft industry wondered how it was possible to have overlooked the line from the gasoline-tank vent to the air-intake scoop leading to combustion-type cabin heaters.

We all recognize that new-type aircraft in the last few years have become more and more complex, and where one man could expect to have a good grasp of the whole construction details of earlier commercial air-transport aircraft, today there are engineering specialists who direct their entire attention to only one phase of the work, such as airframe, engine, heating and air conditioning, electrical systems, to cite a few examples. Then, too, people have asked how this accident could happen when it is common knowledge that a new-type aircraft undergoes exhaustive tests before it is certified by the Civil Aeronautics Administration and must comply in its systems and components with requirements of the Civil Air Regulations. However, in spite of every safeguard, since humans are capable of error, a seemingly small detail overlooked by everyone connected with the project or not evaluated properly can make the product unsafe.

Following the Bryce Canyon and Gallup accidents there was a voluntary grounding of DC-6 equipment, and a modification board was established made up of well-qualified men to scrutinize recommendations for design changes in the aircraft. Proposed modifications were made and thereafter the aircraft was returned to air-line schedules. Again, a small detail was not given proper weight, and on June 17, 1948, another DC-6 crashed near Mt. Carmel, Pa. with fatal injuries to 39 passengers.

Responsibility for the accident was contested bitterly between the operator and manufacturer,[3] but the cause of the accident, without going into the details upon which liability was fixed, was found by the Civil Aeronautics Board to be excessive concentrations of carbon dioxide released from the baggage compartment into the pilot's cabin. Because of its toxic effect this gas produced anoxia in the crew. With the crew incapacitated, the aircraft flew an erratic course until finally it crashed. The plaintiff's substantial recovery against both defendants in the DeVito lawsuit and the most interesting facts have made this case something of a landmark in the law of manufacturer's liability. Nevertheless, in no way has it changed the generally accepted law that a manufacturer is liable for damages arising from its provable negligence.

On the other side, however, lawyers specializing in plaintiff's negligence cases appear to have construed the DeVito case to mean that they should join the manufacturer as a defendant whenever possible, regardless of the merits of the case. This tendency has been noticeable recently but it is discouraging because it is also expensive and time-consuming for the plaintiff to prepare his lawsuit against the manufacturer, taking testimony in distant places. Just as soon as lawyers learn that it is not profitable in every case without regard to facts to include the manufacturer as a defendant with the air carrier, it occurs to us, aircraft and aircraft-component manufacturers will be subjected to fewer of these harassing lawsuits.

In the meantime, people in the industry constantly are sharing their experience and taking full advantage of lessons learned through the costly experience of the past in the effort to make their product safe. They have found out the extent to which a series of accidents can injure their position, and that the expense, inconvenience, and risk of litigation are not things that can be simply passed along to the insurer, to be forgotten by the insured, since premium necessarily reflects experience.

[1] Assistant Director of Claims, United States Aircraft Insurance Group, New York, N. Y.

[2] "Is Your New Product Safe," by J. V. Grimaldi, MECHANICAL ENGINEERING, vol. 75, February, 1953, pp. 122–124 and 148.

[3] DeVito versus United Air Lines, Inc., and Douglas Aircraft Company, Inc., 98F, Supplement 88.

# Coal and Ash Handling

COMMENT BY CARL E. MILLER[4]

This paper[5] is an excellent presentation of the engineering and economic aspects of handling coal and ashes automatically from small boiler plants. Rather than elaborate on these two phases of the subject, which the authors have handled admirably, the writer would like to add one additional thought, namely, the psychological aspects of applying such equipment. Undoubtedly the authors are well aware of these aspects, but chose to concentrate on engineering and economics in order to emphasize better the dollar value of such equipment.

One of the major factors in shifting from coal to oil as fuel in steam generators of the size range up to 100,000 lb per hr, is the operator's preference toward the type of plant in which he is not required to handle either coal or ashes. This situation is a long-standing one and is important to recognize in addition to economics. At the present time there are a sufficient number of small boiler plants in operation equipped with proper coal and ash-handling equipment to show that this operation can be done in a way that is completely acceptable to the operator. The modern systems described by the authors accomplish this objective in three ways:

1 They make the plant easy to keep clean.

2 They eliminate the manual labor involved in handling a bulk of material.

3 They make the actual operation of the plant more interesting because of the additional responsibility for equipment.

The necessity of considering the human factor in obtaining maximum performance from any operation is being realized more and more. In the proper application of coal and ash-handling equipment, we are taking a substantial step toward improving the acceptability of coal-firing in these plants and, as the authors point out, it will pay a return on invested capital because of lower fuel costs.

COMMENT BY J. B. SAXE[6]

The authors are to be congratulated on their presentation. The subject is an important one since coal is the basic boiler fuel and all steaming installations should provide for its use.

The setting up of bogeys for investment in coal and ash-handling is particularly interesting. Such yardsticks will assist the engineer in keeping these facilities in proper perspective with the installation as a whole.

The application of such equipment as the light-duty car shaker, portable car-thawing unit, portable car unloader, and lift truck is not well known and in this particular the paper is informative.

While live storage of a week is desirable, it becomes excessively costly except for a very small plant. However, investment in live week-end storage from Friday to Monday is almost always profitable. The cost of silos and bunkers is greatly increased because the live storage must be elevated. There is need for a highly reliable conveyer which can lift coal from the bottom of a low-level bin or bunker and convey it to the stoker hoppers.

The hanging up of wet coal in bunker outlets, chutes, and other points remains largely unsolved. Many attempts have been made to solve this problem but a complete solution continues to elude us.

Vacuum and hydraulic ash systems are excessively costly for the smaller plants which must resort to semimanual portable equipment.

It is hoped that the paper will stimulate thought on the problems outlined, particularly by the equipment manufacturers who, to a certain extent, have neglected the field of smaller plants.

AUTHORS' CLOSURE

Mr. Miller has brought out some very important points about giving the boiler-room personnel good working conditions and an incentive to do a good job in burning coal. A man with a shovel and wheelbarrow seldom makes a good fireman.

Mr. Saxe's comments were also well taken. Our recommendation on the capacity of coal-storage bins for a one-week supply specifically applies to the small and medium sizes of industrial plants. We agree that one-week live storage in the largest industrial and utility plants would tend to become excessively costly. In such large plants, facilities can be complete enough to operate safely on three to four days' supply of in-plant storage. The smaller plant must minimize on labor wherever possible, therefore, one-week in-plant storage is invariably justified when coal is received in railroad cars.

The coal-flow problems are difficult to solve in cases like one European plant where the coal contains an extremely high percentage of clay and other foreign matter. However, the types of coal that are and can be marketed in this country are seldom troublesome to designers of Mr. Saxe's high caliber. The trouble develops primarily in the smaller plants where, for example, an 8-in-diam conveyer is selected on a capacity basis while a 14 or 16-in. conveyer might be needed to avoid flow restriction with the normal coal supply.

D. M. GIVEN,[7]
CARL A. MARSHALL.[8]

[4] Manager, Stoker Division, Combustion Engineering, Inc., New York, N. Y. Mem. ASME.

[5] "Handling Coal and Ashes Economically in Smaller Plants," by D. M. Given and C. A. Marshall, MECHANICAL ENGINEERING, vol. 75, pp. 125–129 and 148.

[6] Engineer, Gibbs & Hill, Inc., New York, N. Y. Mem. ASME.

[7] Fuel Engineer, Fairmont Coal Bureau, New York, N. Y. Junc ASME.

[8] Managing Director, Fairmont Coal Bureau, New York, N. Y. Mem. ASME.

# Woodworking Machinery

COMMENT BY W. S. WILLIAMS[9]

The paper[10] by Mr. Mansfield is concise and gives a good idea of the woodworking industry as I have known it for more than 50 years.

Possibly the author is familiar with the restored pioneer village in Indiana Spring Mill State Park, near Mitchell, Ind.

One of the features of the restoration is a combination grist and sawmill driven by a water wheel more than 50 ft in diameter. The sawmill is of the drag-saw type with a sliding frame. A sort of turbine, actuated by the water coming off the big wheel, operates the feed of the log carriage. It also is equipped with wood mortise bevel gears. The writer believes that this mill antedates 1850.

There is a great deal of historical material of this kind on which to elaborate; but one would hardly know where to begin.

[9] Chief Engineer, J. A. Fay & Egan Company, Cincinnati, Ohio.

[10] "Woodworking Machinery—History of Development From 1852–1952," by Judson H. Mansfield, MECHANICAL ENGINEERING, vol. 74, December, 1952, pp. 983–995.

# REVIEWS OF BOOKS

*And Notes on Books Received in the Engineering Societies Library*

## W. H Carrier

WILLIS HAVILAND CARRIER, FATHER OF AIR CONDITIONING, with a foreword by Cloud Wampler. By Margaret Ingels. Country Life Press, Garden City, N. Y., 1952. The book is available at Doubleday Bookstores or from Carrier Corporation, Department PR3, 300 S. Geddes Street, Syracuse, N. Y. Cloth, 5¹/₄ × 8¹/₄ in., plate, chronological table and references, bibliography, 170 pp., $2.50.

REVIEWED BY J. K. FINCH[1]

IN general terms it is the task of the engineer to shape man's environment more closely to his needs and wants and to make it possible for us to secure these needs and wants with the least possible labor. Engineering has also been the great equalizing force in the rise and spread of civilized life. Transportation has minimized the inequalities of geography opening the world to economic development and bringing not only to the farm but to far lands the comforts and conveniences formerly enjoyed only by the city dweller. Modern urban life is likewise essentially an engineering creation, engineering providing the community services which in rural areas are largely home-grown. Engineering has also been a powerful force in equalizing social inequalities, in freeing man from the tyranny of men. Mechanical and electrical power have not alone multiplied man's physical resources a hundredfold but made slavery not simply unnecessary but uneconomic. Similarly, the medical profession usually claims the credit for improvements in public health that engineering has made possible through ever higher and more widespread standards of living and material welfare. Modern lighting also has turned night into day and now another inequality, the weather, which Mark Twain once said we could talk about but do nothing about, has succumbed to at least partial control by the engineer.

It is always dangerous to claim that any single man has been the father of any one of these engineering advances. Stephenson did not invent the locomotive although he may justly be claimed as the Father of the Railway Industry. Watt did not originate the steam engine but his labors did inaugurate the Power Revolution. Invention has been described as the marriage of an idea with the means of its realization but industries acquire fathers when needs are found for ideas. The present volume emphasizes this essential wedding of an idea with a need. That Willis H. Carrier had much to build upon in finding means to achieve his ideas is made clear by the long "Chronological Table of Events Which Led to Modern Air Conditioning" which occupies some fifty pages of this small book. One is also duly impressed by the mechanical ingenuity and inventive resourcefulness of the Father of Air Conditioning. But, to the present reviewer at least, Carrier's vision and persistence in seeking out needs and uses for his air-conditioning ideas constitute his major contribution in the field which he so largely created, marks him not only as a versatile inventor but as the Father of the Air-Conditioning Industry.

It was just over fifty years ago, in 1901, that this young Cornell graduate went to work for the Buffalo Forge Company. His early work was on heating plants and drying apparatus for lumber and coffee, but his superiors gave him the opportunity to develop new ideas through research. He turned to studies of humidity control in lithographing and other industries where variable moisture conditions interfered with the quality of output. The problem was involved by changes in temperature which, of course, affected the relative moisture content, but progress was made even more difficult because the manufacturers of the day viewed air conditioning with skepticism and considered the cost excessive. He met the first of these challenges by compiling a handbook which, after eight years of labor, was published in 1914. The second led to the organization of the Carrier Air Conditioning Company of America as a separate concern for, as Dr. Carrier later remarked, they "did not use the parent company's name so that, in case the company was not successful, there would be no stigma to the name of the Buffalo Forge Co."

But Dr. Carrier "did not hesitate to move into areas that were uncharted." From textile mills to Madison Square Garden, from mines to trains and ships he developed and applied his ideas on heating and ventilating, on air conditioning and refrigeration, creating a new industry and making possible "man-made weather." Dozens of papers reflect the contributions of Dr. Carrier to the science and art of his specialty and this small book has been published to mark the Golden Anniversary of the founding of the industry he created.

[1] Dean Emeritus and Renwich Professor Emeritus of Civil Engineering, Columbia University, New York, N. Y.

## Books Received in Library

ASTM STANDARDS ON PETROLEUM PRODUCTS LUBRICANTS. Prepared by ASTM Committee D-2 on Petroleum Products and Lubricants. American Society for Testing Materials, Philadelphia, Pa., 1952. 810 p., 9 × 6 in., paper, $5.75. The 135 standards published in this compilation include 119 test methods; 10 specifications; one classification; 3 lists of definitions relating, respectively, to petroleum, specific gravity, and rheological properties of matter; and 2 recommended practices. The standards are arranged in broadly classified groups, with an additional listing of the contents in numerical order of the standards designation.

ASTM STANDARDS ON RUBBER PRODUCTS. Prepared by ASTM Committee D-11 on Rubber and Rubber-Like Materials. American Society for Testing Materials, Philadelphia, Pa., 1952. 680 p., 9 × 6 in., paper, $5. Of interest to both producers and consumers of rubber products, this compilation includes 104 standard and tentative test methods and specifications on rubber and rubberlike materials. Among the tests covered are processibility tests, physical and chemical tests of vulcanized rubber, aging and weathering tests, low-temperature and electrical tests. Specifications are given for such items as automotive and aeronautical rubber, hose and belting, tape, electrical protective equipment, etc.

AERODYNAMICS OF PROPULSION. By Dietrich Küchemann & Johanna Weber. McGraw-Hill Book Company, Inc., New York, N. Y., 1953, 340 p., 9¹/₄ × 6¹/₄ in., bound, $9. Dealing chiefly with jet propulsion, this book treats the aerodynamics of propulsion as distinct from the older airfoil theory which is concerned with the production of lifting forces. The first two chapters cover the gen-

eral thermodynamic and flow aspects of the basic processes of propulsion. Succeeding chapters deal practically with air intakes, fairings, the ducted propeller, the ramjet engine, the turbojet engine, the installation of jet engines, and certain specialized problems. Cooling is covered in detail, and there is a brief discussion of aerodynamic propulsion in nature.

AIRCRAFT STRUCTURAL MECHANICS. By Franz R. Steinbacher and George Gerard. Pitman Publishing Corporation, New York, N. Y., 1952. 346 p., $9^1/_4 \times 6^1/_4$ in., bound, $6.50. This text has been prepared with two factors in mind: the prerequisites provided by the average engineering curriculum, and the time commonly available for instruction in aircraft structures. The included material is divided roughly into three equal parts: The first is concerned with classical applied-mechanics topics of an advanced nature which are essential in the analysis of the airframe; the second treats the calculation of shear lows due to various loadings on the structure; the last part deals with the buckling of various elements used in the airframe.

ATOMIC THEORY FOR STUDENTS OF METALLURGY. (Monograph and Report Series, No. 3). By William Hume-Rothery. Institute of Metals, London, England, second edition, 1952. 331 p., $8^3/_4 \times 5^3/_4$ in., bound, $3.50. The electron theory of metals involves a general background of atomic theory with which the metallurgical student is often unfamiliar. The present book is written primarily for advanced students and research workers, and is intended to provide a bridge by which they may be led to an understanding of the underlying ideas. After an introductory chapter, the chapter headings are as follows: structure of the free atom; assemblies of atoms; free-electron theory of metals; Brillouin-zone theory of metals; electrons, atoms, metals, and alloys. The properties of metals discussed are restricted to those for which the theories provide a reasonably straightforward explanation.

BIBLIOGRAPHY OF RUBBER LITERATURE FOR 1944 AND 1945. American Chemical Society, Division of Rubber Chemistry, Washington, D. C., 1952, 452 p., $9^1/_4 \times 6^3/_4$ in., bound, $5. Continuing the series started with 1935, this present volume lists under 68 classified headings some 4900 specific references, restricted, in general, to items of particular interest to rubber technologists, engineers, etc. All references to the original, reprint, translation, or abstract of any given article or patent will be found in a single reference in the Bibliography. There are detailed subject and author indexes to the items listed, and the list of journal abbreviations provides full titles and publishers' addresses.

COAL MANUAL FOR INDUSTRY. By A. Wyn Williams. Conover-Mast Publications, Inc., New York, N. Y., 1952. 324 p., $8^1/_2 \times 6$ in., bound, $5.50. This practical work is intended to help the coal user to select and buy the right coal for his needs and to use it properly for maximum productivity. It covers the chemistry and physical properties of coal, the practical aspects of combustion and heat transfer, coal-firing systems, coal preparation, air pollution, coal types, coal handling and storage, and the economic aspects of coal buying and use. Basic technical data are contained in a short appendix.

DESIGNING BY PHOTOELASTICITY. By R. B. Heywood. Chapman & Hall Ltd., London, England, 1952. 414 p., $8^3/_4 \times 5^3/_4$ in., bound, 65s. The determination of stress concentrations is a necessary but difficult aspect of machine-part design. This book provides a comprehensive treatment of the photoelastic method of stress analysis with emphasis on the engineering aspects. Part 1 covers basic information on the polariscope, photoelastic materials, the preparation and testing of models, and the application of model stresses to prototypes. A separate chapter is devoted to frozen-stress technique. Part 2 deals with specific stress concentrations in notches, holes, screw threads, bolts and nuts, and with the effective application of the procedure to improvement of designs. There is a large bibliography.

DAVIDSON'S RAYON, SILK AND SYNTHETIC TEXTILES. 58th Annual Standard Guide, 1953. Davison Publishing Company, Ridgewood, New Jersey, 1953. 536 p., $7^1/_2 \times 5$ in., bound, $6. This annual index reports on rayon, nylon, other synthetics, and silk manufacturers; yarn manufacturers; throwsters, dyers, finishers, printers, and sanforizers; agents, brokers, factors, importers, and converters; New York offices and salesrooms of mills; dealers in raw silk, thrown and spun silk, rayon, and nylon; waste and yarns. A classified directory by products is included as well as statistical tables, a technical compendium of yarn tables, and a complete alphabetical mill index.

ELEMENTS OF NUCLEAR REACTOR THEORY. By Samuel Glasstone and Milton C. Edlund. D. Van Nostrand Company, Inc., New York, N. Y., 1953. 416 p., $9^1/_4 \times 6^1/_4$ in., bound, $4.80. This volume presents the whole field of nuclear-reactor theory and provides for the engineer the basic knowledge for an understanding of reactor technology. Based on lectures given at Oak Ridge, the book begins with the more elementary physical concepts and processes of nuclear reactions, and then develops at length the fundamental principles involved in the calculation of the critical conditions for chain reacting systems—including both homogeneous and heterogeneous reactors—giving detailed mathematical derivations. The book concludes with an explanation of the transport theory and the use of slowing-down kernels.

INTRODUCTION TO HYDRAULICS AND FLUID MECHANICS. By Jacob O. Jones. Harper & Brothers, New York, N. Y., 1953. 403 p., $8^1/_2 \times 5^1/_2$ in., bound, $6. The author's intent is to provide a text which can be covered in the time alloted in an engineering curriculum, and yet include the topics most likely to be of use to engineers and to serve as an introductory course to advanced study. Approximately the first half of the book is concerned with basic material on fluid pressure, similitude, flow through pipes, flow in open channels, and dynamics of streams. The remainder deals with hydraulic machinery—pumps, the impulse wheel, reaction turbines—with the measurement of rate of flow, and with the fundamental aspects of compressible flow.

HYDRAULISCHE ANTRIEBE. By A. Dürr and A. Wachter. Carl Hanser Verlag, Munich, second edition, 1952. 215 p. $8^1/_2 \times 6$ in., bound, 14.80 Dm. Avoiding purely theoretical discussion, this book is devoted to describing the details and illustrating the practical applications of hydraulic drives and controls for machine tools such as the following: lathes, single-spindle automatics, duplicating automatic lathes, multiple-drilling machines with sequence feed, circular saws, semi-automatic turret lathes, vertical boring mills with hydraulic feed, straight-line millers, and thread-milling machines.

### *Library Services*

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

PRINCIPLES OF AERODYNAMICS. By Daniel O. Dommasch. Pitman Publishing Corporation, New York, N. Y. 1953. 389 p., $9^1/_4 \times 6^1/_4$ in., bound, $7.50. The purpose of this text is to describe and define the physical laws which are basic to aerodynamics and the methods used to apply these laws to specific problems. Beginning with the stream function and other basic flow characteristics, the book proceeds with detailed analyses of various types of compressible and incompressible flow, ending with a brief discussion of viscosity effects. Mathematical operations are fully carried out, a chapter on vector operations and the complex variable being provided for those who need it.*

QUALITY CONTROL AND INDUSTRIAL STATISTICS. By Acheson J. Duncan. Richard D. Irwin, Inc., Homewood, Ill., 1952. 663 p., $9^1/_4 \times 6^1/_4$ in., bound, $9. Intended primarily as a college text, this book has been thoroughly indexed and cross-referenced for the practicing engineer and research worker. The chapters are sufficiently independent to allow them to be studied in any desired order. The chapter headings are as follows: fundamentals; acceptance sampling by variables; control charts; statistics useful in industrial research. Selected mathematical proofs, special tables, other helpful technical data, and a glossary are contained in appendixes.

RADIOISOTOPES IN INDUSTRY. Edited by John R. Bradford. Reinhold Publishing Corporation, New York, N. Y., 1953. 309 p., $9^1/_4 \times 6^1/_4$ in., bound, $8. Based on a series of lectures presented at Case Institute of Technology, this book covers all of the important industrial uses of radioactive isotopes. The original material has been revised to include the most recent developments. Important related topics are also considered, such as laboratory construction, shielding, personnel protection, handling techniques, and radioactive waste disposal. This is a comprehensive treatment including the recently developed industrial uses of gross fission products.

SERVOMECHANISM ANALYSIS. By George J. Thaler and Robert G. Brown. McGraw-Hill Book Company, Inc., New York, N. Y., 1953. 414 p., $9^1/_4 \times 6^1/_4$ in., bound, $7.50. Beginning with basic principles and other background material, the authors proceed to detail the mathematical methods for analyzing servo systems, stressing the elements of analysis as being a necessary preliminary to design. Included are discussions of transient analysis, polar transfer function, logarithmic transfer function analysis, etc., and two special features in line with recent developments: relay servomechanisms, and the root-locus method, a means of computing transient response from the transfer-function equations. Considerable

space has been devoted to detailed discussion of physical systems. There is a bibliography.

STEAM LOCOMOTIVE IN AMERICA. Its Development in the Twentieth Century. By Alfred W. Bruce, W. W. Norton & Company, Inc., New York, N. Y., first edition, 1952. 443 p., $9^1/_2 \times 6^1/_2$ in., bound, $7.50. This book is devoted primarily to technical details of the steam locomotive as a form of prime mover. Following an introductory historical chapter, the author discusses the development of the locomotive generally, of power transmission, and of the basic elements of the locomotive, in the form of case histories. Also treated in this manner are the histories of some 60 individual types in the U. S., giving the origin, development, and present status of each. Separate chapters describe special-service locomotives and the competitors of the steam locomotive. In addition to detailed sketches, there are photographs of 168 locomotive types.

SUB-STATION PRACTICE. By T. H. Carr. Chapman & Hall Ltd., London, England, second edition, 1952. 467 p., $8^3/_4 \times 5^3/_4$ in., bound, 55s. This companion volume to the author's, "Electric Power Stations," deals thoroughly with all aspects of substation design, construction, and operation. The early chapters describe types of substations, structures and outdoor equipment, and plant layout. Switchgear, transformers, converting plant, and protective equipment are also considered. The concluding chapters discuss technical considerations and questions of organization and control. The book is intended to serve as a reference work for engineers as well as a test for students.

SYMPOSIUM ON FLAME PHOTOGRAPHY. American Society for Testing Materials, Philadelphia, Pa. (Special Technical Publication No. 116), 1952. 120 p., $9 \times 6$ in., paper, $2. The eleven papers included in this symposium present a brief review of flame photometry, describe several currently used photometers and procedures, discuss certain special problems, and give detailed methods for some specific determinations, such as tetraethyllead in gasoline. References to other material accompany most of the papers.

TABLES AND FORMULAS FOR FIXED END MOMENTS OF MEMBERS OF CONSTANT MOMENT OF INERTIA. By Paul Rogers. Frederick Ungar Publishing Company, New York, N. Y., 1953. 95 p., $9^1/_2 \times 6^1/_4$ in., bound, $3.75. A comprehensive manual for structural-design engineers that gives solutions of fixed-end moments for rigid frames and continuous beams, thereby eliminating the solution of any formulas. Each loading condition is separately indicated with a loading diagram, mathematical formulas, tables of fixed-end moment coefficients, and charts.

TABLES OF CHEBYSHEV POLYNOMIALS $S_n(x)$ AND $C_n(x)$. (Applied Mathematics Series, No. 9). National Bureau of Standards. (For sale by Superintendent of Documents, Government Printing Office, Washington 25, D. C.), 1952. 161 p., $10^1/_2 \times 8$ in., bound, $1.75. A further addition to a series providing tabulated mathematical functions which previously have been wholly unavailable or available only in fragmentary or shortened form. The present table is to 10 decimals and has the usual, for this series, detailed introduction explaining the method of calculation and the specialized uses of the tabulated material.

VENTILATOREN. By Bruno Eck. Springer-Verlag, Berlin, Germany, second edition, 1952. 304 p., $9^1/_4 \times 6^1/_2$ in., bound, 36 Dm. In the new edition of this book on the design and operation of centrifugal and propeller fans the sections on radial and axial fans have been enlarged, and new sections have been added on the following topics: cross-current fans, meridian-accelerated axial fans, noise and wear, new diffusors, small blowers, boiler fans, free-running ventilators, strength calculations, and review of fan testing.

WOOD PRESERVATION. By George M. Hunt and George A. Garrett. McGraw-Hill Book Company, Inc., New York, N. Y., second edition, 1953. 417 p., $9^1/_4 \times 6^1/_4$ in., bound, $7.50. The aim of the authors has been to summarize the essential facts on wood preservation and to provide a clear presentation of its fundamental principles. The various agencies of wood deterioration, wood preservatives, preserving processes and equipment, and the properties of treated wood are all discussed fully. Separate chapters deal with the economic aspects of preservative treatment and with fire-retarding treatments. Significant developments of recent years have been incorporated in the new edition.

# ASME BOILER CODE

## Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting March 6, 1953, and approved by the Board on April 30, 1953.)

### CASE No. 1164

*(Special Ruling)*

*Inquiry:* When high strength carbon steel plates, forgings, pipes, tubes and castings conforming to an approved specification and having a specified minimum yield strength of 31,000 psi are used for the construction of vessels under external pressure, under what rules shall they be designed and fabricated?

*Reply:* It is the opinion of the Committee that high-strength carbon steel plates, forgings, pipes, tubes and castings that conform to the requirements of an approved specification and have a specified yield strength of at least 31,000 psi may be used for the construction of vessels under external pressure and the vessels may be stamped with the Code symbol provided the following requirements are complied with:

(1) The applicable rules in the 1952 Edition of Section VIII of the Code covering vessels under external pressure when constructed of carbon steel shall be adhered to.

(2) The thickness of shells and heads, and the required moment of inertia for stiffening rings shall be determined from the chart in Fig. UCS-28.2.

### CASE No. 1165

*(Special Ruling)*

*Inquiry:* Prior to the adoption of rules for non-ferrous materials in Section IX, may the special requirements for procedure and welder qualifications given in Cases dealing with non-ferrous materials be used in qualifying welding procedures and welders for construction under the 1952 edition of Section VIII of the Code?

*Reply:* It is the opinion of the Committee that the special requirements in the form of exceptions to the requirements of Section IX that are given in Cases 864, 934, 994, 1074, 1106, 1108 and 1114 may be used with the requirements given in the 1952 edition of Section VIII for the materials to which they apply.

## Errata

A typographical error was made in the caption for Fig. UHA-28.3 in Case No. 1122-2 as printed in the April issue of MECHANICAL ENGINEERING (p. 342). The figure for Max Carbon should be 0.03 as given in paragraph (1)(a) of the Reply. This correction has been made in the revision of the Case Book referred to in the following announcement:

## Announcement

A 136-page new edition of Interpretations of the ASME Boiler and Pressure Vessel Code has just been published. It contains the latest revisions of all still current Cases in the previous edition and loose-leaf Interpretations printed in the intervening three years. The price for the new Case Book is $3.00 and the subscription price for the subsequent Interpretations is $5.00 a year.

# ASME NEWS

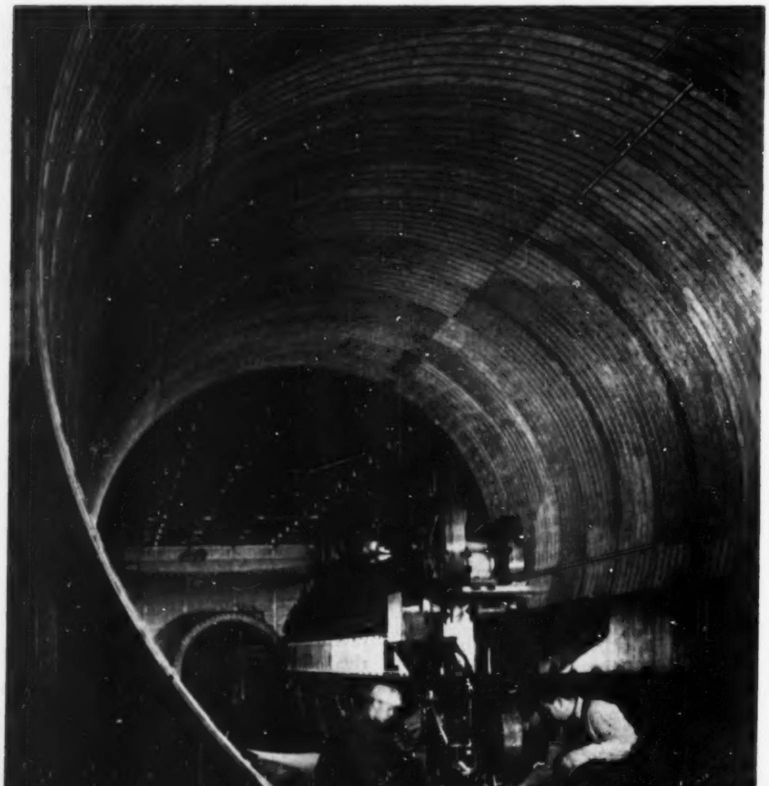
*With Notes on the Engineering Profession*

## Plans for the 1953 ASME Semi-Annual Meeting in Los Angeles Offer Many Important Technical Sessions, Symposiums, and Inspection Trips

### *Headquarters—Hotel Statler, June 28–July 2*

ENGINEERS from all over the nation and abroad will converge on Los Angeles, Calif., from June 28 through July 2 for the 1953 Semi-Annual Meeting of The American Society of Mechanical Engineers. This is the first such meeting ever held in the Southland, and reflects the fast-growing importance of the West in the huge and complex modern engineering field.

With headquarters at the Hotel Statler, the convention will feature more than 40 technical sessions, luncheons, inspection trips to local Southland industrial plants, and entertainment.



C. F. BRAUN & COMPANY TO BE VISITED DURING THE 1953 ASME SEMI-ANNUAL MEETING, JUNE 28–JULY 2

(An automatic welding machine applies a stainless-steel lining to a section of a large fractionating column.)

#### Technical Sessions

Fifty technical sessions of the four-day conclave will be devoted to subjects including aviation, materials handling, machine design, and gas turbines, applied mechanics, management problems, production engineering, fuels, oil and gas power, and lubrication. Some 150 speakers, including prominent research, project and production engineers, and university professors, are slated to address the engineers on such subjects as the development of ramjet power, turbocompressors, propulsion wind tunnels, artillery rockets, the history of aviation, the smokeless burning of waste-process gases, and nuclear power plants.

Among the high lights of the meeting will be luncheons sponsored by the Heat Transfer, Petroleum, Aviation, and Gas Turbine Power Divisions of ASME, and the American Rocket Society, at which guest speakers will be leading industrialists. A. C. Rubel, vice-president of exploration and production, Union Oil Company of California, is the speaker for the Petroleum Division Luncheon. His subject is "Petroleum's Place in Our Industrial Future." William F. Nash, Management Committee, C. F. Braun & Company, is the speaker for the Junior Forum. His subject is "The Future's Unlimited—Let's Get Ready." The President's luncheon will feature an address by F. S. Blackall, jr., president of ASME.

#### Inspection Trips

Southland industrial plants to be visited on inspection trips include those of Lockheed Aircraft Corporation, C. F. Braun & Company, Lever Brothers, French Sardine Company, Exchange Lemons Products Company, and Hyperion Treatment.

The American Society of Mechanical Engineers, known as a "Founder" society in the engineering profession, includes more than 37,000 engineers divided into eight regions nationally, and more than 18 professional divisions. Founded more than 72 years ago, ASME is devoted to promoting the art and science of mechanical engineering, and allied arts and sciences; the promotion of research and fostering of engineering education; the advancement of engineering standards; and the broadening of the usefulness of the engineering profession.

With more than 1800 members and headquarters in Los Angeles, the Southern California Section of ASME ranks fourth nationally in membership by city. Officers of the Section include C. M. Sandland, chairman; F. P. Baeyertz, vice-chairman; L. F. Richardson, secretary-treasurer.

# The President's Page

## *The Fiftieth Anniversary of Powered Flight*

THE fiftieth anniversary of the epoch-making flight of Wilbur and Orville Wright at Kittyhawk will fall on Dec. 17, 1953. A committee, under the dynamic chairmanship of Lieut. Gen. James H. Doolittle, composed of eminent leaders in engineering and industry, has been engaged for some months now in stimulating the observance of this important milestone of the modern age.

It is an anniversary of particular meaning to The American Society of Mechanical Engineers. Ours was the first professional group to evidence an interest in the newborn science of aviation and aeronautics—an interest which has continued active and vigorous to this day. It is significant that, as early as December, 1908, even before the Wright brothers had completed their flight tests for the United States Army Signal Corps, a paper was presented on "The Present Status of Military Aeronautics," by Major (later Major General) George O. Squier, Signal Corps, U. S. A., at the Annual Meeting of the Society in New York, N. Y.

General Squier's paper was later published in the Society's Transactions. In leafing through the files of Transactions and Mechanical Engineering, one finds constantly recurring evidence of the Society's concern with this revolutionary science and the new industry which it spawned. Indeed, for many years, the ASME was the only professional society which provided an avenue of expression and a forum for the interchange of ideas among aeronautical engineers.

Over thirty years ago the ASME Aviation Division was formed, and it has continued as an active and articulate segment of the Society to this day, numbering among its chairmen and members many of the leaders in this field.

The great importance of aviation to the mechanical-engineering profession needs no emphasis here, but some may be surprised to know that it is already the second largest employer of labor in the United States. In 1953 the scheduled air lines of our country will carry some 29 million passengers for a distance of more than fifteen billion miles. In contrast with the 16-hp engine which drove the Wright brothers on their initial flight of 120 feet in 12 seconds, jet engines now perfected will develop more than 10,000 hp, driving a plane at supersonic speeds exceeding a thousand miles an hour.

But the end is not yet. Despite the tremendous advances which have been made, the opportunities for new and improved designs of engines and ships are still so great as to offer one of the major challenges to the young engineer, who, in a more than usually literal sense, would hitch his wagon to a star.

The American Society of Mechanical Engineers hails the Wright brothers' great achievement in this jubilee year, and in doing so, salutes the vast industry which has grown from the seed which they planted at Kittyhawk. Our Society rightly shares that industry's pride in the tremendous achievements of the past half century, many of which were contributed directly by past or present members of ASME. We pledge a continued recognition of the Society's obligations and opportunities in this vitally important field.

Frederick S. Blackall, jr., *President*
The American Society of Mechanical Engineers

# 1953 ASME Applied Mechanics Division Conference to Be Held in Minneapolis, June 18–20

## *University of Minnesota Will Be Site for 18th National Conference*

THE Eighteenth National Applied Mechanics Conference of The American Society of Mechanical Engineers will be held June 18–20, 1953, at the University of Minnesota, Minneapolis, Minn., with the co-operation of the ASME Minnesota Section. A Symposium on Digital and Analog Computers and Computing Methods, one of the main features of the conference, will be presented on Friday, June 19.

This year's technical program will be presented at eight sessions and laboratory and research facilities of the University will be open for inspection throughout the conference. Although no formal tours are planned, lists of the laboratories and facilities will be available at the registration desk which will be located in the main lobby of the Mechanical Engineering Building. Trips will also be arranged, upon request, by the Committee on Inspection Trips, to the St. Anthony Falls Hydraulic Laboratory, Rosemount Aeronautical Research Center, and industrial plants in the Twin Cities area.

The Woman's Auxiliary of the ASME Minnesota Section has arranged a program for the women on both Thursday and Friday. This program will include special luncheons, tours, and a drive to points of interest in and around Minneapolis and St. Paul. Details of the women's program will be available at the registration desk.

In addition to the annual Banquet on Friday night, a Get-Together Dinner and Social Hour has been planned for Thursday night by the Minnesota Section. E. N. Kemler, general chairman of the conference, will act as toastmaster, and a welcome address will be given by D. B. Chenoweth, chairman, ASME Minnesota Section.

The tentative program follows:

### THURSDAY, JUNE 18

**8:30 a.m.**

Registration

**9:30 a.m.**

#### Session (1)

**An Analytical Theory of Creep Deformation of Metals,** by *Yoh-han Pao* and *Joseph Marin,* Pennsylvania State College (Paper No. 53—APM-3)

**The Application of Limit Analysis to Punch-Indentation Problems,** by *R. T. Shield* and *D. C. Drucker,* Brown University (Paper No. 53—APM-21)

**On the Use of Singular Yield Conditions and Associated Flow Rules,** by *W. Prager,* Brown University (Paper No. 53—APM-23)

(By Title) **Influence of Viscous Effects on Impact Tubes,** by *C. W. Hurd,* USN, Electric Boat Co., *K. P. Chesky,* USN, Boston Naval Shipyard, and *A. H. Shapiro,* Massachusetts Institute of Technology (Paper No. 53—APM-10)

**1:30 p.m.**

#### Session (2)

**The Vibration of Rotating, Tapered-Twisted Beams,** by *G. W. Jarrett* (deceased), University of Pennsylvania and Westinghouse Electric Corp., and *P. C. Warner,* Westinghouse Electric Corp. (Paper No. 53—APM-17)

**Methods for Solving Problems of Transverse Impact on Beams and Plates,** by *A. C. Eringen,* Illinois Institute of Technology (Paper No. 53—APM-27)

**Buckling of Multiple-Bay Ring-Reinforced Cylindrical Shells Subject to Hydrostatic Pressure,** by *W. A. Nash,* David Taylor Model Basin, USN (Paper No. 53—APM-29)

(By Title) **The Influence of Load Characteristics on Plastic Deformations of Beams Under Concentrated Dynamic Loading,** by *P. S. Symonds,* Brown University (Paper No. 53—APM-26)

**1:30 p.m.**

#### Session (3)

**Laminar Swirling Pipe Flow,** by *Lawrence Talbot,* University of California (Paper No. 53—APM-24)

**Axisymmetric Flow of an Ideal Incompressible Fluid About a Solid Torus,** by *Eli Sternberg* and *M. A. Sadowsky,* Illinois Institute of Technology (Paper No. 53—APM-7)

**Two-Dimensional Flow Through a Diffuser With an Exit Length,** by *K. R. Galle,* Boeing Airplane Company, and *R. C. Binder,* Purdue University (Paper No. 53—APM-20)

**Analysis of Viscous Laminar Incompressible Flow Through Axial-Flow Turbomachines With Infinitesimal Blade Spacing,** by *T. P. Torda, H. H. Hilton,* and *F. C. Hall,* University of Illinois (Paper No. 53—APM-28)

**6:30 p.m.**

#### Get-Together Dinner and Social Hour

### FRIDAY, JUNE 19

**8:30 a.m.**

Registration

**9:30 a.m.**

**Symposium on Digital and Analog Computers and Computing Methods**

#### Symposium (1)

**Analog Solution of Beams Excited by Arbitrary Force,** by *W. T. Thomson* and *T. A. Rogers,* University of California

**A Synchro-Operated Differential Analyzer,** by *Arnold Nordsieck,* University of Illinois

**New Analog Computers and Their Application to Aircraft-Design Problems,** by *G. D. McCann,* California Institute of Technology

Panel Discussion on Applications of Analog Computing Equipment

**1:30 p.m.**

#### Symposium (2)

**Digital-Computer Methods for Solving Linear Algebraic Equations and Finding Eigenvalues and Eigenvectors,** by *D. J. Wheeler* and *J. P. Nash,* University of Illinois

**High-Speed Digital Computers and Their Application to Problems of Applied Mechanics,** by *S. N. Alexander,* U. S. National Bureau of Standards

**Automatic Solution of Mechanical Problems,** by *E. L. Harder,* Westinghouse Electric Corp.

Panel Discussion on Applications of Digital Computers

**7:00 p.m.**

Banquet

Presiding: Dana Young, *chairman,* Applied Mechanics Division

Speaker: Mina Rees, *director,* Mathematical Sciences Division, Office of Naval Research

Subject: **Future Field of Application of High-Speed Computers**

### SATURDAY, JUNE 20

**8:30 a.m.**

Registration

**9:30 a.m.**

#### Session (4)

**Remarks on the Combined Bending and Twisting of Thin Tubes in the Plastic Range,** by *E. T. Onat* and *R. T. Shield,* Brown University (Paper No. 53—APM-18)

**A Graphical-Numerical Solution of the Problems of Saint-Venant Torsion and Bending,** by *B. A. Boley,* Columbia University (Paper No. 53—APM-22)

**Elastic Spheres in Contact Under Varying Oblique Forces,** by *R. D. Mindlin* and *H. Deresiewicz,* Columbia University (Paper No. 53—APM-14)

**Toroidal-Shell Expansion Joints,** by *N. C. Dahl,* Massachusetts Institute of Technology (Paper No. 53—APM-30)

(By Title) **The Shearing of a Rectangular Block Between Rough Plates,** by *J. W. Craggs,* University College, Dundee, Scotland (Paper No. 53—APM-1)

(By Title) **The Torsion of Spiral Rods,** by *H. Ôkubo,* Tohoku University, Japan (Paper No. 53—APM-2)

(By Title) **Some New Types of Orthotropic Plates Laminated of Orthotropic Material,** by *C. B. Smith,* University of Florida (Paper No. 53—APM-6)

(By Title) **Reinforced Circular Holes in Bending With Shear,** by *S. R. Heller, Jr.,* USN, Bureau of Ships (Paper No 53—APM-9)

**1:30 p.m.**

#### Session (5)

**Axisymmetric Flexural Temperature Stresses in Circular Plates,** by *J. E. Goldberg,* Purdue University (Paper No. 53—APM-5)

**Thermal Stress in Pipes,** by *Henry Parkus,* Michigan State College (Paper No. 53—APM-19)

**An Improved Electrical Analogy for the Analysis of Beams in Bending,** by *W. T. Russell,* U. S. Army, and *R. H. MacNeal,* California Institute of Technology (Paper No. 53—APM-11)

(By Title) **Solutions of the Problem of Heat Conduction With the Aid of the Inverse Method,** by *F. S. Weinig,* General Electric Company (Paper No. 53—APM-25)

(By Title) **Transient Thermal Stresses in Slabs and Circular Pressure Vessels,** by *M. P. Heisler,* North American Aviation, Inc. (Paper No. 53—APM-8)

**1:30 p.m.**

#### Session (6)

**Determination of Stresses in Cemented Lap Joints,** by *R. W. Cornell,* United Aircraft Corp. (Paper No. 53—APM-15)

**Effect of Range of Stress on Fatigue of 76S-T61 Aluminum Alloy Under Combined Stresses Which Produce Yielding,** by *W. N. Findley,* University of Illinois (Paper No. 53—APM-12)

**Calculation of Elastic Displacements From Photoelastic Curves,** by *H. Poritsky* and *R. P. Jerrard,* General Electric Co. (Paper No. 53—APM-16)

**The Solution of the General Three-Dimensional Photoelastic Problem,** by *M. M. Frocht,* Illinois Institute of Technology, and *R. C. Guernsey, Jr.,* General Electric Co.

(By Title) **High-Temperature Compression Testing of Graphite,** by *Leon Green, Jr.,* Aerojet Engineering Corp. (Paper No. 53—APM-4)

# Fire Protection and Safety Research Group Formed

FORMATION of a fire protection and safety research group—the first service of this type especially for Midwest industry—was announced at Armour Research Foundation of Illinois Institute of Technology.

Head of the group will be John J. Ahern, director of Illinois Tech's department of fire protection and safety engineering.

William A. Casler, Mem. ASME, assistant director of research at the Foundation, ex-

plained that companies sponsoring fire-protection and safety research at the Foundation will have one or more of these objectives: To prevent fire or explosions from starting; to limit the spread of fire after it has started; to provide for prompt detection of fires; to provide for prompt extinguishment; and to prevent accidents.

The Foundation is prepared to help develop new or improved products, materials, equipment, and instrumentation to meet basic fire-protection and safety requirements and standards and to undertake research and development problems in such fields as: Combustion (studies on explosive characteristics of gases and dusts; of flame propagation, or spontaneous heating); acoustics (sound-control techniques, materials and their burning characteristics); toxicology (detection of harmful vapors and dusts; poisonous effects of materials); and explosives (experimental techniques, handling, and storage of explosives).

## Nine Scientists to Study NBS

A NINE-MAN committee of nongovernment scientists began a study on April 29, 1953, of the National Bureau of Standards at the request of Sinclair Weeks, Secretary of Commerce. He asked for a "thorough, objective, and impartial" examination of all the Bureau's operations that should "be a guide in determining the most effective role for the Bureau."

Mr. Weeks announced on April 3 that he had asked Detlev W. Bronk, president of The Johns Hopkins University and president of the National Academy of Sciences, to organize the committee.

The investigation committee is headed by M. J. Kelly of Bell Telephone Laboratories, representing the National Academy of Sciences. James W. Parker, past-president and Hon. Mem. ASME, represents the Society.

## Meetings of Other Societies

**June 15–19**
Basic Materials Conference, June 16–18, Hotel Roosevelt, will supplement the first Exposition of Basic Materials for Industry, June 15–19, Grand Central Palace, New York, N. Y.

**June 17–19**
American Management Association, general management conference, Hotel Statler, New York, N.Y.

**June 23–27**
American Society for Engineering Education, annual meeting, Dartmouth College, Hanover, N. H.

**June 28–July 1**
American Society of Refrigerating Engineers, fortieth spring meeting, Lake Placid Club, Lake Placid, N. Y.

**June 29–July 3**
American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

**July 5–10**
International Institute of Welding, annual assembly, The Technical University of Copenhagen, Copenhagen, Denmark

(*ASME Calendar of Coming Events, see page 515*)

## Joint ASTM-ASME Symposium Highlights ASTM Annual Meeting in Atlantic City

THE fifty-sixth annual meeting of the American Society for Testing Materials, June 29–July 3, 1953, to be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., features among the scheduled technical sessions a Joint ASTM-ASME symposium on Metallic Materials at Low Temperature. This symposium will begin Sunday evening, June 28; continue in three sessions on Monday, morning, afternoon, and evening; and be concluded Tuesday morning.

### Need for Literature Stressed

Despite the existence of a large accumulation of data, technical papers, and reports on the low-temperature properties and behavior of metallic materials, sudden unexpected, and frequently disastrous, failures continue to occur in engineering structures and expensive equipment. Very little of the wealth of available information has been fully evaluated and found its way into the commonly used handbooks. Furthermore, it is apparent that there is a lack of general comprehension and application of the knowledge which has been reported by investigators concerning important metallurgical and mechanical variables and their influence on low-temperature ductility and the mechanism of fracture.

### Symposium on Metallic Materials at Low Temperatures

Consequently, the Low Temperature Panel of the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals is sponsoring a Symposium on Metallic Materials at Low Temperatures to bring together and summarize the state of knowledge of the subject, up to the present, in an effort to make designers and materials engineers more fully cognizant of the joint role played by metallurgical and mechanical factors in their influence on the behavior of metals at low temperatures, and particularly of the variable response to variations in stress systems, strain rates, and size effects.

In this Symposium, the treatment of structural carbon steel receives more attention than other metallic materials because of its extensive application and consequently great importance in engineering structures. The first three papers, which result from the extensive and well-directed studies of ship steel and ship structures, provide a sound foundation for the entire program. However, the five sessions of the Symposium, devoted as they are to (1) the evaluation of brittle failures in ships and engineering structures, (2) criteria of metal behavior for design engineers, (3) metallurgical and mechanical factors, (4) significance and reliability of notch-toughness tests, and (5) certain aspects of current research, including new data on titanium, quenched and tempered steels at high-strength levels, and several types of cast irons, provide a broad coverage which should go a long way toward eliminating many misconceptions regarding the function and suitability of laboratory and simulated service tests, and also give design engineers a new approach to design criteria.

It is recognized that in the time which is available it will not be possible to present a complete evaluation and correlation of all recent research and no attempt is made to do this or to present an exhaustive review of existing data on low-temperature properties of engineering metals. However, it is believed that the Symposium program provides for one of the most comprehensive and authoritative presentations of this complex but very timely subject.

## IRE Convention Held in New York City

### *Electronics Exhibit at Grand Central Palace*

THIRTY thousand engineers and scientists, representing nearly every country outside the Iron Curtain, convened for the forty-first annual convention of the Institute of Radio Engineers at the Grand Central Palace, Waldorf-Astoria Hotel, and Belmont Plaza, New York, N. Y., March 23–27, 1953.

A four-day program of over two hundred technical papers, covered the latest advances in such fields as computers, electronic navigation, color television, and guided missiles.

The convention featured a ten-million dollar exhibition of electronic apparatus at the Palace, revealing important scientific developments of over 400 of the country's leading research laboratories and manufacturers. Exhibits ranged from devices which use diminutive transistors in place of radio tubes to a full-size ultra-high frequency (uhf) television station.

Institute President James W. McRae, vice-president of Bell Telephone Laboratories, was chairman at the opening session, during which the nine surviving radio pioneers who formed the Institute in 1912 were honored.

The program of technical papers was highlighted by a special symposium on "Electronics in Flight" on Tuesday evening.

A panel of internationally known leaders in the electronics, aerodynamics, and aircraft-operations fields, moderated by Prof. C. S. Draper of the Massachusetts Institute of Technology, discussed the role of electronics in modern aircraft-control systems.

Brig. Gen. David Sarnoff, chairman of the board of RCA, was the principal speaker at the annual banquet on Wednesday when he discussed "Electronics and the Engineer." On that occasion General Sarnoff was named the first recipient of the Institute's newly established Founders Award, bestowed on outstanding leaders in the radio-electronic field. The award was given "for outstanding contributions to the radio engineering profession through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare."

The Institute's highest technical award, the Medal of Honor, was presented to John M. Miller, Naval Research Laboratory, Washington, D. C., for his pioneering scientific and engineering contributions.

# Columbus Plays Host to ASME at 1953 Spring Meeting, April 28–30

## *Variety of Technical Material and Social Events on Program*

AMID Ohio's sesquicentennial celebrations, Columbus, capital city of Ohio, took time out to play host to the more than 750 members and guests of The American Society of Mechanical Engineers, in attendance at the Spring Meeting, April 28–30, 1953, held at the Deshler-Wallick Hotel. The engineers, coming from many parts of the United States—also England and Canada—were offered a well-planned and interesting technical program at which some 63 papers were presented at 25 technical sessions by representatives of education, industry, and government. In addition, inspection trips to six plants, in and around Columbus, were scheduled on Wednesday, April 29, giving some idea of the city's vast research, manufacturing, and production facilities. Social events included the President's Luncheon on Tuesday, April 28, the Roy V. Wright Luncheon and Lecture on Wednesday, April 29, a banquet Wednesday evening, and a special program for the women.

### President's Luncheon

Choosing for his theme the subject, "For a Stronger and More Dynamic Society," ASME members and guests who were gathered at the President's Luncheon on Tuesday, heard ASME President Frederick S. Blackall, jr., emphasize that ASME *is*, in fact, a strong dynamic society. He said, "ASME is sound financially and growing in membership. It is directed by a really diligent council, chosen from its members, and administered by a staff of unusual competence. It serves an enthusiastic group of leaders, present and potential, in one of our nation's great creative professions, whose standards of performance it has done much to raise to eminence. We take justifiable pride in the broad scope, both geographical and technical, of our meetings, and the excellence of our publications. Our codes and standards, having saved our nation and its industries countless millions of dollars and who knows how many lives, have become prerequisites to our nation's defense. Our Society has made major contributions to and given tremendous stimulus to research. In brief, we have a record which evokes eternal acclaim and internal enthusiasm, as the attendence at this great Spring Meeting attests—but who is there among us—however fierce his pride or content with his lot—who does not wish and would not aspire to make it better!"

Enlarging upon some of the problems confronting the Society at present, Mr. Blackall pointed out that the turnover in the Junior Grade is too high—or so it seems to the Council—and we are trying to ferret out the reasons why and do something about it.

There is a problem of turnover, too, in the membership casualties at the stage of transfer upon graduation from Student to Junior Member. This transfer, Mr. Blackall said, should be made easier than it is now, at least financially.

ASME PRESIDENT FREDERICK S. BLACKALL, JR., *left*, AND S. R. BEITLER AT PRESIDENT'S LUNCHEON

Continuing, the President said, "At the other end of the scale, however, is the lesser but none the less challenging problem of the former ASME member who, having reached the pinnacle of his career, perhaps in management or some other field not calling for constant exposure to engineering problems, loses his interest in the Society and drops the membership which he once so eagerly sought. Perhaps the fault here is a defect in our public-relations activities. To correct this, the Executive Committee at its meeting in Columbus gave consideration to a plan for broadened public relations, consistent with the purse and purposes of ASME."

Turning to the publications of the Society, Mr. Blackall said it is important that we keep MECHANICAL ENGINEERING in a position of eminence and, if possible, broaden its influence. "MECHANICAL ENGINEERING has served and is serving its purpose admirably," he said, "but I am looking ahead, not backward, and perhaps even trying to peek over the horizon a bit. If we clearly understand and agree upon its objectives, perhaps we may discover that their attainment would be furthered by some restyling of its content, its editorial policy, even its type face and format. At least, we should make it our business to take a fresh look often enough to insure that we do not lag in the publishing parade."

Another problem of immediate concern is how to meet the problems of an expanding technology in our meetings programs and in the organization and activities of divisions. Mr. Blackall revealed that the Board on Technology is preparing a comprehensive plan for reshaping our national program and will report at the 1953 ASME Semi-Annual Meeting in Los Angeles, Calif., in June. Similarly, the Organization Committee is attacking the problem of providing the best possible outlet for creative thinking in the Professional Divisions. Every possible effort, he said, should be made in our publications policy and meetings programs to meet the specialized needs of the professional groups.

"The expansion of engineering horizons makes it important, too, that the Society's research program be administered wisely and with discretion. Our problem here is not to compete, but rather to stimulate private and corporate research. There are, however, certain fields of broad and general interest, though they may be more pertinent to one professional division than another, to which a society-sponsored research program is especially suited."

"Of course," Mr. Blackall stated, "the great opportunity for stimulating creative interest and accomplishment by and among engineers is at the grass roots. Here is where our Society will flower or wither on the vine. Every possible step should be taken to assist the sections in developing interesting meetings and interest *in* meetings. In this connection, it is of paramount importance that there be the utmost co-operation between the section officers and the officers of the professional divisions, particularly at the program-making level."

Ralph A. Sherman, Fellow ASME, general

chairman of the meeting, extended the city's greetings and welcomed ASME members and guests to the meeting. Prof. S. R. Beitler, Fellow ASME, the Ohio State University, presided.

### Roy V. Wright Luncheon and Lecture

Governor Frank J. Lausche of Ohio, delivered the Roy V. Wright Lecture at the luncheon on Wednesday. The lecture is given in honor of the late Dr. Wright, a past-president of ASME and former state senator of New Jersey, who was noted for his activities in impressing upon engineers the duties and responsibilities of citizenship in a democracy.

During the course of his lecture, in which he gave some historical facts and background of the state of Ohio, Governor Lausche posed the following question: "How is it that in these United States we were able to develop economy of the type which exists in our country?" He said, "Some will answer that the United States is gifted with abundant natural resources and therefore was able to develop its great life and society." But, according to the Governor, that is not the answer. For example, Russia has an abundance of natural resources, slave-labor camps, concentration areas in the satellite nations, and a proletarian people who are compelled to work as slaves for a dictator so that he might impress upon the world the achievement that comes to a communistic nation. "And," said the Governor, "I can practically hear the voices of these people, who are carrying that load, crying out to the dictator, 'Lift from my back this load; I can't carry it; let me live as a dignified human being.'" But the answer is, "Toil on, slave, for the benefit of the state until life leaves your body."

"There are others who will say that in the United States we are fortunate people. Many young Americans believe that we, by our Creator, were gifted with intellect that is not possessed by other people in the world. That answer, of course, is not sound because we know that geographical location of birth, color of skin, religion, and all other accidental factors do not determine what intellect shall be." What then is the answer for this great achievement in the United States of America? Governor Lausche declared that there is only one answer—we have achieved this great life because in America the individual is supreme and government is secondary. "American government has been instituted only for one purpose—to maintain the dignity of the human being. We place the individual on a pedestal and we say to him, friend or stranger, rich or poor, strong or weak, you are a child of God and you are dignified and worthy of the respect of your fellow men. We say to him, in our country, you shall enjoy these liberties that were intended for you by your Creator at the day of your birth."

"Our constitution of Ohio and that of the United States merely contain in written form a national law dominating man," Governor Lausche pointed out. "We say to the individual, you shall not be convicted of crime unless a jury of 12 of your peers decide you are guilty. You shall have the right to meet your accuser face to face. You shall have the right to a speedy trial and to be defended against the charges that are made against you. You shall have the right to worship God in accordance with your conscience. We will provide educational facilities for you to develop your intellect and to make it possible for you to meet the problems of life, and we shall guarantee to you that whatever you create with your intellect and with your hands shall belong to you. It shall not be taken from you by your neighbor, nor by your government. If it is taken from you, you will have compensation given to you by the government. It is the freedom of the American that has made possible this great productivity of our country."

The President, Frederick S. Blackall, jr., presided.

THE HONORABLE FRANK J. LAUSCHE, GOVERNOR OF OHIO, WHO GAVE THE ROY V. WRIGHT LECTURE, IS CONGRATULATED BY PRESIDENT BLACKALL

### James F. Lincoln Banquet Speaker

The subject "Incentive Management" was discussed by James F. Lincoln, Mem. ASME, president of Lincoln Electric Company, Cleveland, Ohio, at the banquet on Wednesday evening. E. H. Davis, chairman of the board, New York Coal Sales Company, Columbus, Ohio, acted as toastmaster.

Excerpts from Mr. Lincoln's address follow:

"If you read the by-laws of every company organized industrially, you will find that it is organized for profit. But if the only end in view is profit, I think we have gone a long way in the wrong direction. The first thing to do is to make sure that industry is organized for the one sole end of creating or producing a better product to be sold at a lower price. Doing that would leave no doubt that profit would be automatic.

"Suppose we accept the responsibility to succeeding generations and to the economy? What happens? In the first place, all the people in the organization have a new point of view of regarding what their job is. They have lost the previous point of view that what they are after is to try to make more profit for someone they don't even know. There is, instead, the feeling of desire to work together to build these better products at a lower price. After all, the worker is the man who eventually consumes, and that sort of program makes sense to him.

"After you have a program which makes sense, the second thing is to recognize what it is for which we, as individuals, strive. The primary urge in every individual is not for money. It is to have the respect of yourself and the respect of other people. That is the greatest incentive in the world.

"There are a host of plans, of various kinds, which have been attempted by various people for the last hundred years, to get some method whereby you can pay the man more money, and expect that he is going to go ahead, working and developing his ability as you had hoped he would. But most of the plans have entirely overlooked the fundamental drive which is in all of us.

"Our company has been in operation for 18 years. The selling price of our product is less now than it was, even before the last world war (and it's the same product we made 18 years ago), in spite of the fact that all of the things which go into that product, all of the raw materials which we have to buy, have gone up by leaps and bounds. The margin of profit is constant. We have been able to pay as an average, over the last 11 years, more than double the average wage of a laborer doing the same sort of work in the area where our factory is located. The products we manufacture are fundamentally the same—the welding machines, the welding electrodes. There have been small changes in design during that time, but it has been just as expensive to build now as it was then. Yet, we are turning out over nine times as much product per man-hour as we did 18 years ago. This means there has

RALPH A. SHERMAN, GENERAL CHAIRMAN OF THE 1953 SPRING MEETING, AND MRS. MASON PILCHER CHAT DURING LUNCHEON

been not only greater skill, greater co-operation, greater desire, on the part of all the people involved to do a better job, but it also means that the people in the organization want to work together, not only to complete that skill, but also to develop better methods of doing it, better machines to do it, using those machines skillfully, so that the results I have outlined to you have been obtained.

"Do you believe that the industrial system that we have at the present time does anything along that line? Do you think that, with the present friction between labor and management, the present planned program with limitation of output will develop any latent abilities? Do you think there is the slightest doubt but what thousands of Ketterings and Edisons and Watts have gone to their graves with their abilities completely unknown? They had no opportunity and no incentive to develop those abilities which they had. That, I think, is the greatest criticism that can be leveled at the present industrial system."

### Technical Program

Technical sessions during the meeting which enjoyed great popularity were those scheduled by the Gas Turbine Power Division on centripetal and free-piston-type turbines. It was pointed out that centripetal turbines can be designed to handle larger flows and higher enthalpy drops at higher rpm with better efficiency and lower stresses than the axial-flow turbine. Concerning free-piston gas generators, U. S. Naval experts indicated that the free-piston gas generator-turbine power plant combines the high thermal efficiency of the diesel-engine combustion cycle with the simplicity and flexibility of the turbine power take-off. The use of a free-piston gas generator-turbine combination for producing power has long ago passed the theoretical stage, they said.

Of immediate interest to many engineers present was the symposium scheduled by the Power Division on chemical cleaning of heat-transfer surfaces in power plants as well as other power-plant equipment. Chemical cleaning, it was reported, is now applied to all equipment which contains scale and sludge deposits in central stations. A discussion of these various units along with a description of the different types of solvents employed and an explanation of certain types of corrosion were given.

Sessions programmed by the Rubber and Plastics Division also attracted wide interest among those present at the meeting. Such materials as Teflon, a comparatively new polymeric resin; unplasticized polyvinyl chloride, a corrosion-resistant structural material; metal-clad laminates used in printed circuitry; reinforced plastics; and molded rubber were discussed.

In a joint Production Engineering-Metal Processing session, electrospark-machining developments were outlined. Known by the trade name "Method X," this involves the direct application of electricity to the machining of conductive work materials.

The Management Division offered two interesting panels; one on a unified theory of organization and management and the other on an application to engineering cost estimating.

In addition, papers were presented in such fields as fuels, heat transfer, machine design, process industries, hydraulics, and oil and gas power.

Page 502 contains a list of preprints that were made available at the Meeting. The list is arranged according to divisions. In the ASME Technical Digest section of this issue of MECHANICAL ENGINEERING, 16 digests of Spring Meeting preprints appear. Digests of any remaining Spring Meeting preprints will be published in the ASME Technical Digest section of forthcoming issues of MECHANICAL ENGINEERING.

NEW CONVEYER DEMONSTRATED

(Truman Foster demonstrates a model of a conveyer which appeared Tuesday night on the "Engineering Your Life" show over WBNS-TV at 9:30. This program, presented by The American Society of Mechanical Engineers, illustrated how mechanical engineers use the basic laws of science to put energy and materials to work for people. Members of the cast, *left to right*, are S. M. Marco, M. L. Smith, T. G. Foster, and C. D. Jones, all of the department of mechanical engineering at the Ohio State University, and Otto Slack, co-ordinator of the "Engineering Your Life" series.)

### Plant Trips

Six plant trips were scheduled during the meeting, all on Wednesday, April 29. ASME members and guests were given the opportunity to visit one of the following: Jeffrey Manufacturing Company, Ternstedt Division of General Motors Corporation, Battelle Memorial Institute, National Electric Coil Company, Denison Engineering Company, or The Diamond Power Specialty Corporation.

At the Jeffrey Manufacturing Company members and guests saw facilities for manufacturing, mining, processing, and handling equipment; chains, transmission machinery, and other related equipment. Facilities for laying out complete handling and processing systems for the application of industrial units were inspected. The group also visited the company's modern research and testing laboratory and chemical and metallurgical laboratories.

Another group visited the Ternstedt Division of General Motors Corporation. At this modern plant they saw the high-volume mass production of automobile parts and trimmings, such as door locks, window frames, and springs.

A third group visited Battelle Memorial Institute. Here they were shown some of the research projects for which Battelle has gained an international reputation. Fields of research with which Battelle has been connected include metallurgy, fuels and combustion, ceramics, corrosion technology, electronics, nucleonics, and many others.

Facilities for manufacturing replacement coils for rotating electrical machinery, redesigning and rewiring motors and generators, and for making electrical insulation material were viewed by another group at the National Electric Coil Company.

At the Denison Engineering Company ASME members and guests were shown a plant where hydraulic presses with capacities from 1 to 75 tons have been developed. The group also saw facilities for producing a complete line of hydraulic pumps, fluid motors, valves, and controls for systems up to 5000 psi.

A plant for manufacturing soot-blowing and deslagging equipment for boilers and related equipment was inspected by members and guests at The Diamond Power Specialty Corporation. The company also showed the group machinery for manufacturing a complete line of boiler-drum level gage and alarm equipment for intermediate and high-pressure boilers, and a wide variety of other industrial equipment, including the production of industrial-television apparatus which is currently finding wide usage both in the plant and in the field.

### Women's Program

An interesting variety of events were arranged for the women in attendance at the meeting. The program started out on Tuesday, April 28, with the President's Luncheon held in the ballroom of the Deshler-Wallick Hotel. Later that day women guests attended a tea given by Mrs. Frank Lausche in the Governor's Mansion. At this tea Mrs. Elmer R. Kaiser spoke on "Famous Ohio Ladies, 1803–1953." In the evening the women attended a musicale given at the home of Mrs. Elmer R. Kaiser at which Louise Yost McDonald was vocalist and Mrs. S. H. Yost, accompanist. On Wednesday, April 29, there was a luncheon at the Scioto Country Club, followed by cards. That evening the women joined with the men in attending the banquet held in the headquarters hotel ballroom.

The program concluded with a luncheon on Thursday, at the Maramor.

### Committees

The committees in charge of arrangements for the Spring Meeting included the following: *Meetings*, J. W. Barker, chairman; Jess H. Davis, Roland W. Flynn, Glenn R. Fryling, J. K. Louden, Thomas A. Marshall, Jr., C. W. Parsons, and W. M. Morley; *General*, Ralph A. Sherman, chairman; *Technical Events*, Richard B. Engdahl, chairman; John Corsiglia, Jesse W. Huckert, S. M. Marco, and Vernon R. Peterson; *Inspection Trips*, Dan H. Vogel, chairman; Glenn E. Haney, John Norton, Richard H. Zimmerman, and Harry P. Wilson; *Printing and Signs*, Walter L. Hartman, chairman; John D. Cowan and Glenn E. Haney; *Hotel Arrangements*, Ernest B. Lund, chairman; Charles W. Pharo and John C. Rehard; *Entertainment and Reception*, Harry C. Ballman, chairman; Samuel R. Beitler, John F. Cunningham, Jr., Herbert C. Johnson, Ralph J. Kramer, Arthur P. McCoard, J. Mason Pilcher, Paul B. Purdy, Walter Robinson, and William T. Reid; *Publicity*, Marion L. Smith, chairman; James R. Barnum, Albert M. Rockwood, Walter L. Starkey, and John E. Voorhees; *Information and Registration*, Ca.' J. Lyons, chairman; Richard D. Ellsworth, Donald A. Hinckle, John D. Hummell, Charles D. Jones, and Robert L. Teare; *Finance*, Elmer R. Kaiser, chairman; Harry M. Blank, Allan P. Johnson, Jr., Glen S. Pierce, Edwin M. Sampson, William A. Welcker, Jr., and Samuel H. Yost; *Women's Activities*, Mrs. Bertrand Landry, chairman.

## ASME Calendar of Coming Events

**June 18–20**
**ASME Applied Mechanics Conference, University of Minnesota, Minneapolis, Minn.**
*(Final date for submitting papers was Feb. 1, 1953)*

**June 28–July 2**
**ASME Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.**
*(Final date for submitting papers was Feb. 1, 1953)*

**Sept. 21–25**
**ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Sherman Hotel, Chicago, Ill.**
*(Final date for submitting papers was May 1, 1953)*

**Sept. 28–30**
**ASME Petroleum Mechanical-Engineering Conference, Rice Hotel, Houston, Texas**
*(Final date for submitting papers was May 1, 1953)*

**Oct. 5–7**
**ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.**
*(Final date for submitting papers was June 1, 1953)*

**Oct. 29–30**
**ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.**
*(Final date for submitting papers was June 1, 1953)*

**Nov. 29–Dec. 4**
**ASME Annual Meeting, Statler Hotel, New York, N. Y.**
*(Final date for submitting papers—July 1, 1953)*
*(For Meetings of Other Societies, see page 511)*

EXAMPLES OF MECHANICAL-ENGINEERING RESEARCH WERE SHOWN ASME MEMBERS DURING VISIT TO BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

[Robert W. Smith (*back to camera*), staff member, explains a project on folding doors to (*left to right*): Alan Howard, General Electric Company, Schenectady, N. Y.; Joseph Nusbaumer, E. I. du Pont de Nemours & Company, Inc., Seaford, Del.; Edwin L. Pace, General Electric Company, Fitchburg, Mass.; Jack Fatharier, National Malleable and Steel Castings Company, Cleveland, Ohio; and Hayden W. Ingalls and John V. Long, Solar Aircraft Company, San Diego, Calif.]

# Junior Forum

Conducted by Joseph Schmerler[1]

## Engineering—Opportunity Unlimited

UNDER the auspices of The American Society of Mechanical Engineers National Junior Committee, another in the series of conferences on problems of concern to young engineers was held in Columbus, Ohio, on Tuesday evening, April 28, as a part of the 1953 ASME Spring Meeting. Speaking on the theme, "Engineering—Opportunity Unlimited," were two prominent editors of widely known engineering publications, Everett S. Lee, Fellow ASME, *General Electric Review*, and George F. Nordenholt, Mem. ASME, *Product Engineering*. As usual at these conferences, the Old Guard Committee, of which F. D. Herbert, Sr., and Carl F. Dietz are co-chairmen, had as its guests representatives from sections in Region V in which the meeting was held.

Present and taking an active part in the conference discussion were the following: T. M. Phillips of the West Virginia Section, Donald L. Block, Youngstown, Harold A. Hudachek, Cleveland, R. F. Cornish, Canton-Alliance-Massilon, Edward J. Goetz, Jr., Cincinnati, James W. Gorham, Akron, John Mooney, Columbus, Richard A. Cederberg, Pittsburgh, and James Gallagher, Erie. Raymond L. Hollaway, Jr., of New Philadelphia, Ohio, acted ably as chairman of the conference for which many ASME officers were also on hand, as well as numerous other interested engineers of all ages.

The formal address by Mr. Lee can best be characterized as inspirational and represented firsthand evidence that genuine enthusiasm for engineering can be retained and even increased in the course of a distinguished professional career. Those present heard an engineer who had spent many years in research affirm that its limitless opportunities are what give engineering its greatest charm, its greatest motivation for achievement, and its greatest strength and power.

Tracing important events in engineering history through such personalities a Christopher Columbus, Leonardo da Vinci, Benjamin Franklin, and Thomas Edison, Mr. Lee expressed the view that the engineer of the future—as of the past—will be found in the forefront of everything new. He pointed out that young engineers have an obligation to tell those even younger of the opportunities in engineering and to guide those qualified into serious consideration of engineering as a career.

[1] Jun. ASME.

JUNIOR MEMBERS AND GUESTS OF THE OLD GUARD—REPRESENTING SECTIONS IN REGION V—ATTEND JUNIOR SESSION DURING 1953 ASME SPRING MEETING

(In front row, *left to right*, are: James W. Gorham, Akron; Donald L. Block, Youngstown; Richard A. Cederberg, Pittsburgh; T. M. Phillips, West Virginia; in back row, *left to right*, are: Harold A. Hudachek, Cleveland; James Gallagher, Erie; John Mooney, Columbus; Edward J. Goetz, Jr., Cincinnati; and J. Colebrook.)

In contrast to and yet complementing Mr. Lee's idealistic approach was Mr. Nordenholt's down-to-earth realism. As one who "cut his engineering teeth" through diversified shop experience and has maintained the direct forthrightness of the man at the machine, Mr. Nordenholt stated that engineering is in the saddle today, and the world cannot get along without the engineer. Referring to engineering education, he expressed the belief that engineers are all too often berated for what they do know and belittled for what they do not know. Although recognizing the importance of the humanities, he contended that engineering graduates are capable of reading and comprehending liberal-arts subject matter as a part of their professional development while gaining industrial experience.

Mr. Nordenholt expressed what might be termed a healthy skepticism toward the shortage of engineers. Other considerations aside, he declared that there exists some rather obvious squandering of engineers in non-engineering jobs as well as the overmanning of some engineering departments. He raised the question as to what would be the responsibility of the engineering societies should a condition arise in which engineers are "surplus" and there are more jobs than engineers.

Needless to say, the two formal addresses provoked some thoughtful discussion and aroused in the minds of those present the desire to carry many of the ideas back to their local ASME Sections. Several questions were asked concerning the standing of the engineer compared to that of the doctor or the lawyer. Apart from agreement concerning the personal relationships and the independent-contractor status characteristic of the medical and legal professions, opinions differed widely. Several of the young engineers appeared somewhat envious of the standing of their counterparts in other professions and the support they received from their professional societies. One Junior sharply dissented, stating that he did not feel that ASME wanted any part of the hierarchy characteristic of the medical and legal professions, though he thought that the latter had done a particularly good selling job before the public, something which the engineering societies could well emulate. In another direction, several older engineers cautioned against viewing these other professions with colored glasses, noting that individual human characteristics are what count for most in any profession.

As always is the case at Junior Conferences, engineering education entered prominently into the discussion. Questions were raised as to the effect of overly narrow specialization upon opportunities for engineers. An engineer well known in the utility industry decried the reluctance of young graduates to perform menial tasks as a part of their early industrial experience, stating that all too often they are too impatient and exhibit a short-range instead of a long-range viewpoint.

Young engineers were criticized by one of their elders for their proneness to ask superiors for answers instead of taking responsibility on their own, a criticism which led to a question concerning how much professional attitude engineering students actually acquire

from engineering professors. Here again experience in the medical profession was cited, it being pointed out that medical faculties are composed almost entirely of practicing doctors, while heretofore opportunities for engineers in industry to take qualified leaves of absence for teaching purposes have been virtually nonexistent. As one discusser indicated, far more interchange along such lines is necessary for students to acquire attitudes worthy of professional men.

Concluding the discussion were remarks by F. S. Blackall, jr., president, and Eugene O'Brien, past-president. Mr. Blackall strongly urged the development of the professional point of view, cautioning that it required perseverance and initiative. Decrying the fact that engineers are all too often inarticulate, Mr. Blackall stressed the importance of the ability to put across one's ideas in forceful and convincing fashion. Mr. O'Brien, agreeing with one of the Junior guests who had earlier asked whether we are giving young engineers "the heart" to become members of their profession, counseled that there is great need for more *pride in being an engineer.*

# Engineers' Role in Management Emphasized at Detroit Meeting, April 15-16

## *First Engineering-Management Meeting Held at Rackham Building*

THE great enthusiasm shown by the more than 450 engineering executives who attended the first annual Engineering-Management Conference sponsored by the Management Division of The American Society of Mechanical Engineers, demonstrated that contrary to popular belief, engineers are concerned with the human aspects of industrial activity. They eagerly accepted the advice given by Walker L. Cisler, Fellow ASME, keynote speaker for the conference held at the Rackham Building, Detroit, Mich., April 15-16, 1953, that "[engineers'] interest in management problems is a recognition of new responsibilities growing out of the scientific and engineering contributions of the profession." The engineers in attendance participated actively in discussions of the management aspects of engineering operation.

The engineers who attended the sessions, at which top-management programs concerning engineering activities, effective engineering, selection, training, and supervision of engineers were discussed, came from 27 states and two provinces of Canada. Industrial-organization representatives came from such distant points as Crockett and Pasadena, Calif., Anniston, Ala., and Atkinson, N. H. Sixty per cent of those in attendance were nonmembers of ASME, indicating the great interest in engineering-management problems by men who in the future will look to ASME leadership in the development and dissemination of new management approaches to complex management problems.

### European Efficiency Versus American Management

"The increasing productive efficiency of the European manufacturing organizations poses a real challenge to American engineering management," said F. S. Blackall, jr., president, ASME, at the dinner meeting. He pointed out that European machine toolmakers have been making great inroads in traditionally American sales areas and that the policies of the Mutual Security Administration have been a contributing factor to these developments. Those who heard the talk were left with a new awareness of the danger of complacency and of the need for surpassing the great progress being made in Europe in the application of automation, the training of apprentices, and the development and application of new machine tools.

### Executive's Responsibility

C. A. Wiken, Mem. ASME, emphasized the importance of the executive's responsibility to stimulate and encourage research and development in connection with new products. Presenting the paper prepared by W. F. Rockwell, Jr., and relating the experience of the Rockwell Manufacturing Company, Mr. Wiken pointed out specific opportunities available for increasing the effectiveness and intensity of product development and research.

In the Wednesday afternoon session, Mervin J. Kelly spoke about the problems encountered in the original planning and construction of the Murray Hill Laboratories of the Bell Telephone Company. He pointed out that the original buildings provided great flexibility in the conduct of research activity and that the soundness of the basic design was borne out by the fact that the same approach was followed in the construction of the substantial expansion of the laboratories recently completed. The design has been applied in principle by other research laboratories and Dr. Kelly invited inquiries concerning the present facilities. In the same session the procedures available for controlling the progress on engineering projects were discussed by C. C. Winston. "Digital computers can be applied to the extension of the engineer's skill and increase the effectiveness of engineering analysis," said Allen Keller, Mem. ASME, who gave illustrations of the application of these computers to the

FIRST ANNUAL ASME ENGINEERING MANAGEMENT CONFERENCE BANQUET

(Seated at head table are, *left to right*, W. A. Carter, chairman, ASME Detroit Section; Arthur M. Perrin, chairman, Management Division; F. S. Blackall, jr., president ASME; James W. Parker, past-president ASME, who presided; Kenneth A. Meade, director of educational relations, General Motors Corporation; E. S. Theiss, vice-president, Region V; T. E. Winkler, Mem. ASME, Department of Public Works, Detroit; and Ercole Rosa, Jr., secretary, Management Division.)

M. J. KELLY, PRESIDENT F. S. BLACKALL, JR., AND WALKER L. CISLER, FELLOW ASME, *left to right*, STOP FOR A CHAT AT THE FIRST ANNUAL ASME ENGINEERING MANAGEMENT CONFERENCE

solution of problems concerning the design of steam turbines.

### Human Relations in Engineering

The Thursday morning session was devoted to the human-relations problems in engineering management. John Gammell, Assoc. ASME, presented numerous examples from his own extensive experience to show the need for adequate appreciation of the person-to-person relationships existing in the selection process. Emphasizing the need for greater attention to the training of engineers, Mr. Gammell revealed the strides being made in Russia in the training of technical personnel. Continuing the discussion of the steps involved in making the engineer a satisfied, contributing member of the team, John Whitmore of Airborne Instruments Laboratories, Garden City, N. Y., discussed the basic personality needs of the engineer and gave suggestions for the applications of present knowledge concerning the energy motivations "pride, profit, pleasure, comfort, security, and sometimes—fear" to the more effective integration of the new engineer into the engineering department. The session was concluded by R. F. Pearse, who pointed out that "engineers can and do make good executives." Recent research in psychology has produced techniques for evaluating the personality need of specific individuals. When this information is available, programs of development can be designed which will overcome the personality deficiencies of the individual and contribute to his development as an executive capable of handling the personnel relations important to the operation of the successful engineering organization.

### Operating Problems in Management

The Thursday afternoon session of the conference took up the operating problems of engineering management concerned with the opportunities for improving the effectiveness of engineering supervision C. A. Butler, Mem. ASME, emphasized the need for serious study by engineers of the proved principles of engineering management. He pointed out that as a rule engineers prefer not to be guided and that "the engineering profession subconsciously resents conforming to basic principles of management." He concluded that "when the excellence of the engineering profession in managing engineering activities is equal to the excellence of the engineering designs produced in the profession, the profession will be held in much higher regard than it is often held at present." The engineer must constantly reexamine his responsibilities to the successful operation of the company and be guided by the results. This was the suggestion offered by Harmon B. Riehl, Mem. ASME, who added that the engineer's contribution to the success of the company is fundamental and that the engineer-manager must provide leadership, ideas, and sound judgment.

F. R. Benedict, in telling of the "Current Status of Engineering Supervision," presented the results of the Management Development Program conducted at the Westinghouse Company. The first step in the program involved the survey of individual desires of more than 5000 in management, which revealed that the principal desires were for guidance, management training, better communications, and training in specific fields. His discussion further related what action was taken to satisfy these desires and to provide the opportunities for engineering supervision to more effectively handle these problems.

Digests of five of the papers presented at this conference may be found on pages 414-415 of the May, 1953, issue of MECHANICAL ENGINEERING. Digests of remaining preprints appear in ASME Technical Digest section of this issue of MECHANICAL ENGINEERING.

The high level of enthusiasm shown by those who attended the various sessions reflected the benefits received. There was general awareness of the range of problems facing the engineering manager and the active discussion which followed each session proved that further investigation of the problems of engineering management are required. The second annual Engineering Management Conference which will be held in the early spring of 1954, now being planned, will provide the opportunity for further discussion of the management problems of interest to the engineer.

## ASME Boiler Code Committee Meets in Oregon

THE meeting of the Boiler Code Committee of The American Society of Mechanical Engineers was held in conjunction with the twenty-second general meeting of the National Board of Boiler and Pressure Vessel Inspectors, at the Multnomah Hotel, Portland, Ore., April 27–30. More than 250 attended the sessions, which were sponsored by the Oregon Section of ASME.

Technical sessions started at 2:00 p.m., Monday, April 27. After a call to order by Frank W. Smith, chief inspector of boilers of the State of Oregon, the group heard addresses by Governor Paul Patterson of Oregon; W. E. Kimsey, Commissioner of Labor, State of Oregon; J. E. Leddy, chairman, NBBI; S. H. Graf, vice-president, ASME Region VII; F. J. McCanna, chairman, Oregon Section, ASME; H. B. Oatley, chairman, ASME Boiler Code Committee; and C. K. Gabriel, president, Gabriel Boiler and Fabrication Company.

The following day there was a panel discussion on the 1952 edition of the Unfired Pressure Vessel Code, Section VIII of the ASME Boiler and Pressure Vessel Code. Since there have been some major amendments to this section of the code all questions pertinent to Section VIII were discussed. In the afternoon the subcommittees of the ASME Boiler Code Committee met. Wednesday was devoted to a session on all sections of the ASME Boiler and Pressure Vessel Code. The panel session

on Section IV of the ASME Low Pressure Heating Boiler Code took up questions pertaining to recent amendments. In the afternoon a general panel session was held at which all subjects covering construction requirements in any of the ASME Codes together with inspection and data report-form questions were taken up. Many questions and suggestions were directed to the panel. A number of worth-while suggestions, which resulted from these discussions, are considered acceptable to the subcommittees and will be presented at some future date to the Boiler Code Committee.

On Friday an all-day scenic trip was arranged, which included Mt. Hood and other Oregon beauty spots. The party had luncheon at the Timberline Lodge. The women who attended the meeting were not overlooked in the arrangements. In addition to the receptions and trip to Timberline Lodge, there were tours of the city, including the historically significant Forestry Building, Hoyt Aboretum, and Oswego Lake area, and a luncheon at Oswego Country Club. The Oregon Rhododendron Park was at the peak of its spring bloom. Eastmoreland Gardens and the Grotto Sanctuary were also visited. Wednesday was devoted to a tour of the Oregon Coast, with a view of the Pacific Ocean from the Dorchester House; Depoe Bay, with its fishing fleet, was also visited; and on Thursday the women had luncheon at Berg's Chalet, followed by a book review.

## Korean Engineering Colleges Receive New Books Sent by UNKRA Through "CARE"

FOUR South Korean engineering schools will receive approximately $22,000 worth of new books on engineering sent by the United Nations' Korean Reconstruction Agency through CARE.

Part of $150,000 worth of new text and reference books, exclusive of packing and transportation costs, that CARE is buying and shipping to war-depleted Korean universities for UNKRA, the engineering volumes represent over 2000 titles, the headquarters of CARE, New York, N. Y., reports. Ninety per cent are American works, with the balance English, French, and German titles. UNKRA is purchasing additional Japanese titles in the various book categories covered by the project, which will cost an over-all total of $200,000 and provide 50,000 to 60,000 new books for nine universities.

The engineering titles bought by CARE were specifically requested from UNKRA by the recipients: the engineering colleges of Seoul National, Chun Nam, Chun Puk, and Chosun Christian Universities. First shipments arrived in mid-May and will mark the first CARE book deliveries to Korea since the outbreak of hostilities forced the CARE-UNESCO Book Fund to suspend service to that country.

Resumption of service means that individual contributions in any amount can again be sent to the Book Fund at any CARE office to provide new engineering and other scientific and technical books for Korean educational institutions. Donors may designate the catagory of book they wish to send and the institution, or may ask CARE to choose the recipients.

## ASME Region VIII Meeting Held in New Orleans

REGION VIII of The American Society of Mechanical Engineers held its fourth annual meeting at the Jung Hotel, New Orleans, La., April 13–15. The New Orleans Section was host to the following participating sections which make up Region VIII: Kansas City, Mid-Continent, North Texas, Rocky Mountain, and South Texas. The Region VIII Regional Administrative Meeting was held on Sunday, April 12.

The Southern Tier Student Conference of Region VIII, with representatives from Louisiana Polytechnic Institute, Louisiana State University, Rice Institute, Southern Methodist University, Texas A&M, Texas Technological College, University of Texas, and Tulane University, held its meeting in conjunction with the Regional Meeting. There was a total registration of approximately 225, with about half being Student Members.

During the three-day meeting the business of the sections was taken up and plans for the future were formulated; technical papers were presented, and the student papers were heard and judged for the annual Student Papers Award. The papers presented in the technical sessions were interesting and covered such varied subjects as a solution to inadequate river cooling-water supply, use of large-diameter buried pipe for storage of propane, mining sulphur with barges and boats, the development of an acoustic interferometer for measuring the velocity of sound in gases, thermal problems of high-speed flight, and flame-hardening for industry vitalized by precise control.

Papers presented at the Student sessions covered the following topics: Patent law for engineers, steam-jet refrigeration, fundamentals of safety-valve design, engineering aspects of atomic radiation, the twelve-volt ignition system, the rocket motor, lubrication practice for passenger-car engines, and Leonardo da Vinci—the first mechanical engineer.

The welcome address was given by The Honorable De Lesseps S. Morrison, Mayor of New Orleans, at the Luncheon for Students and Members. J. M. Todd, past-president, ASME, acted as chairman of the Banquet. The New Orleans Spring Fiesta was being held at the time of the meeting and tours were arranged to include entree to many of the fabulous ante-bellum Garden District and Vieux Carre homes. The "Patios by Candlelight" tour on Tuesday evening, a high light of Spring Fiesta, was enjoyed by the visitors.

One of the features of the meeting was an inspection trip of the harbor facilities of the City of New Orleans on the yacht, "*Good Neighbor*." The other inspection trips were to the Michaud Ordnance plant of the Chrysler Corporation, where tank engines are built, and the Celotex Corporation, where products using bagasse as raw material are manufactured.

The women's program included a luncheon at Patio Royal and a tour of Vieux Carre, a social hour at the Engineers Club of New Orleans, and the various luncheons and the banquet, which always help to make the meetings so successful.

## People

CHARLES F. KETTERING, Fellow ASME, will be presented with the National Society of Professional Engineers' Award at the society's annual meeting to be held June 18–20, at the Sheraton-Beach Hotel, Daytona Beach, Fla. The award has been bestowed only twice before: to former President HERBERT HOOVER, Hon. Mem. ASME, and D. B. STEINMAN. During this meeting T. CARR FORREST, JR., Dallas, Texas, will be installed as the fifteenth president of NSPE.

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RAYMOND ROACH TUCKER, Mem. ASME, formerly professor of mechanical engineering, Washington University of St. Louis, Mo., was elected April 7, 1953, on the Democratic ticket as Mayor of St. Louis.

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GUSTAV EGLOFF, Mem. ASME, director of research, Universal Oil Products Company, has been elected an honorary member of the Association Francaise des Techniciens du Petrole, Paris, France.

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WILLIAM E. HILL, Mem. ASME, a partner, Turck, Hill & Co., Inc., New York, N. Y., was appointed chairman of the Industry Advisory Council to the Yale (University) Engineering Association. The function of the council will be to provide Yale with a first-hand look at management's educational requirements as it trains men for leadership in industry.

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ALFRED W. DOLL, Mem. ASME, professor and head of the department of physics at Pratt Institute, has been named acting dean of the school of engineering to succeed H. RUSSELL BEATTY, Mem. ASME.

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D. G. FAUST, Mem. ASME, chief engineer, C. A. Norgren Company, Englewood, Colo., was presented with the Alfred E. Hunt Award at the annual meeting of the American Society of Lubrication Engineers held in Boston, April 13–15.

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FREDERICK D. ROSSINI, Silliman professor and head of the department of chemistry and director of the American Petroleum Institute Research Laboratory at the Carnegie Institute of Technology, will present the twenty-seventh Edgar Marburg Lecture during the 1953 American Society for Testing Materials annual meeting, Atlantic City, N. J., June 29 through

July 3. JEROME STRAUSS, Mem. ASME, vice-president, Vanadium Corporation of America, New York, N. Y., will be the second H. W. Gillett Memorial Lecturer.

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ALEXANDER J. GRANT, former engineer in charge, Welland Ship Canal, Department of Railways and Canals (now Department of Transport), Welland, Ont.; ALBERT L. KILLALY, former superintending engineer, Trent Canal, Department of Transport, Peterborough, Ont.; FREDERICK P. SHEARWOOD, former chief engineer and later, consulting engineer, Dominion Bridge Company, Montreal, Que.; ARTHUR SURVEYER, Mem. ASME, president, Surveyer, Nenniger and Chenevert, consulting engineers, Montreal, Que.; and STEWART YOUNG, former director of community planning, Province of Saskatchewan, Regina, Sask., were elected to honorary membership of The Engineering Institute of Canada. The certificates of honorary membership were presented at the sixty-seventh annual banquet of the Institute held in Halifax, N. S., May 22.

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PHIL CARROLL, Fellow ASME, was the recipient of the 1953 Industrial Incentive Award presented by the Society for Advancement of Management.

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ADOLF MEYER, Life Mem. ASME, 1935 Calvin Rice Lecturer, retired managing director, engineer in chief, Brown Boveri & Co., Ltd., Baden, Switzerland, will represent the Society at the centenary celebration of L'École Polytechnique de l'Université de Lausanne, June 11–13, 1953.

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ERNEST S. THEISS, vice-president, ASME Region V, represented the Society at the inauguration of G. BROOKS EARNEST as the third president of Fenn College, held May 9, 1953, in Cleveland, Ohio.

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HAMILTON L. STONE, Mem. ASME, represented the Society at the inauguration of Malcolm A. Love as the fourth president of San Diego State College, held May 10, 1953, at San Diego, Calif.

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J. R. BRIGHT, Mem. ASME, editor, *Modern Materials Handling*, delivered the 1953 James Clayton lecture in London, England, before The Institution of Mechanical Engineers, on April 17. The lecture was later given at other chapters of the Institution. The Intelligence Division, Department of Scientific and Industrial Research, held an informal seminar with Mr. Bright at which representatives from government, industry, and research associations had the opportunity to informally exchange ideas on materials handling.

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THEODORE VON KÁRMÁN, Mem. ASME, Chairman, Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization, was among the five men cited for "original and nonconformist thinking," who received $1000 awards from Lord & Taylor at the company's annual award luncheon, held May 4, 1953, at the Waldorf-Astoria Hotel, New York, N. Y.

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M. J. GOGLIA, chairman, Atlanta Section, ASME, was among the 100 selected from a nominee list of more than 1100 Atlanta (Ga.) men between 25 and 40 years of age who have been designated as the city's outstanding prospective "leaders of tomorrow," in a three-month program cosponsored by *Time* magazine and the Atlanta Chamber of Commerce.

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JOHN E. ARMSTRONG, recently retired chief engineer of the Canadian Pacific Railway Company, and MARVIN WILBUR MAXWELL, recently retired chief of the development branch of Canadian National Railways, were the recipients of the 1952-1953 Julian C. Smith Medal awarded by The Engineering Institute of Canada, one of its highest awards.

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ROSS L. DOBBIN, retired engineer and civic leader of Peterborough, Ont., Can., has been elected president of The Engineering Institute of Canada for 1953. Mr. Dobbin represented the Institute at the coronation of Queen Elizabeth on June 2. He left for London immediately following his induction as president at the 67th annual meeting of the Institute.

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LEON T. MART, Fellow ASME, president of the Marley Company of Kansas City, Mo., was elected president of the Cooling Tower Institute at the annual meeting of the group in San Francisco, Calif.

## H. P. Liversidge Tells American Power Conference Industry to Blame for Shortage of Engineers

THE critical shortage of engineers in the United States looms as a threat to industrial progress and economic stability, and industry shares in the blame, Horace P. Liversidge, Fellow ASME, chairman of the board, Philadelphia Electric Company, told the fifteenth annual meeting of the American Power Conference, held in Chicago, Ill.

Mr. Liversidge said that there is an urgent need for thousands of engineers at the present time and that the shortage would continue for the next decade. Emphasizing the immediate need for engineers, the utility official disclosed that just one technological school, Drexel Institute in Philadelphia, had 8344 positions made available to graduates at a time when the school was graduating a grand total of 414 engineering and business-administration students.

He charged that industry shares the blame for the shortage of technologists because in the past it has failed to provide adequate financial aid to engineering schools, and on occasion discouraged students from entering the field. Exhorting industry to greatly expand its financial support of such schools, he declared that such aid should not come under the heading of charity, but be a direct charge against business operations.

Mr. Liversidge warned that the management of American industry would be shortsighted if large-scale industrial expansion is attempted without a parallel increase in facilities for higher technological education.

# ASME Standards Workshop

## Proposed New Flexibility Section Code for Pressure Piping, ASA B31.1

TWO years ago, ASA Sectional Committee B31.1 appointed a Task Force on flexibility for the purpose of critically examining the "Expansion and Flexibility" chapter of section 6 of the Code for Pressure Piping. As a result of intensive work by the Task Force, their assignment has been brought to a near stage of finalization in the form of a report submitted to the Sectional Committee. The report has been accepted for publication and authorization has been given for use of the proposed rules, contained therein, on work coming under the jurisdiction of the Code.

The draft developed by the Task Force can be obtained, free of charge, from the ASME offices, 29 West 39th Street, New York 18, N. Y. Simply ask for "Proposed Flexibility Section—ASA Code for Pressure Piping." A preliminary draft has already been distributed to approximately 150 members of the industry and elicited considerable comment of a constructive nature. The purpose in making latest copies of the report available to the engineering public at large is to invite more comments so as to conclude this work on the basis of the concerted opinion of all concerned. Therefore all who are interested are urged to obtain copies, and, after use and study, to send in their comments and suggestions to L. W. Benoit, secretary, ASA Sectional Committee B31.1, 420 Lexington Avenue, New York, N. Y.

In the preparation of this work, the Task Force has been guided by the results of research and practical experience gained since the conception of the present Code. The intention has been to write regulations providing adequate safety without requiring extravagant use of material; at the same time to impose a minimum of restraint on procedure or method and avoid too stringent requirements regarding mathematical analysis.

One of the most significant changes is the introduction of the concept of stress range.

The term has not been used in the current code although the structure of the current formula for allowable stress implies a range of stress rather than a specific value. The designation "allowable combined stress" has obscured the intention and failed to imply that a piping system should be evaluated along lines different from those followed in the analyses of structures or machinery. The latter are designed to meet a limiting stress or distortion within the elastic limit of the material. A piping system can trespass beyond the elastic range with stress reversals from cold to hot condition provided the number of such reversals remains below certain limits so as to exclude the effect of fatigue. In contrast to structures, piping systems can absorb relatively large displacements without ill effect, changing from one shape to another without returning exactly to a previous configuration. A stress which cannot be sustained in the hot condition will drop to the level which the material *can* sustain. The drop in stress will reappear as cold stress with opposite sign thus springing the system without the application of extraneous work. The relaxation in the first heating cycles tends to establish a condition of permanency. The cold stress has lowered the upper limit of the hot stress causing little or no further relaxation in succeeding cycles. The system eventually attains a state of equilibrium.

Because of this self-springing which occurs whenever the system is stressed above the level that can be sustained either in the cold or in the hot condition, any assignment of credit allowances for cold springing such as is provided in the current Code loses its significance *in so far as stresses are concerned*. On the other hand, in the case of reactions, cold-springing remains significant since damage can be done to equipment in the initial cycle before the system has had time to adjust itself as a result of creep or yielding.

In line with the preceding, it is proposed that calculations of the expansion stress be based on the modulus of elasticity at room temperature for the following reasons:

1 In the case of temperatures in the creep range the stress in the cold condition may be of greater magnitude than that in the hot condition, as the result of cold or self-springing.

2 In the case where lines operate at low temperatures the difference between the hot and cold modulus is very small.

It is evident that the true magnitude of the stresses in either the hot or the cold condition cannot be determined by calculation because the amount of relaxation is unknown and cannot be judged reliably. Stress intensities at any stage are therefore of academic interest only. The only statement that can be made with certainty is that a piping system is safe when the sum of the cold and the hot stress does not exceed a stress range which is considered safe for the expected number of stress reversals.

The following allowable expansion stress range has been proposed on the basis of test data and the results of experience in practice

$$S_A = f(1.25\, S_c + 0.5\, S_h) \quad \ldots\ldots [1]$$

where

$S_A$ = Allowable expansion stress range, psi.

$S_c$ = Allowable stress ($S$-value) in cold condition, psi.

$S_h$ = Allowable stress ($S$-value) in hot condition, psi.

For definitely cyclic conditions Equation [1] is corrected by a stress reduction factor "$f$" which is introduced to take care of the effects of fatigue. Equation [1] covers the expansion stresses only, a separate allowance of $^3/_4\, S_h$ having been set aside for stresses due to weight and longitudinal pressure. A comparison of the present Code formula with the new formula will be found in an appendix, accompanying the proposed draft.

The proposed new flexibility requirements are believed to represent an improvement over those in the current Code in that they provide a rational approach to estimating the controlling reactions at anchorages or equipment connections.

In your study and application of the proposed rules, attention is called to alternate paragraphs 620(*a*) through (*i*), 621(*c*), and 622(*b*). Your comments regarding these sections of the Code are of particular importance.

All members of the Task Force are deserving of the gratitude of the piping industry for contributing so generously of their time and effort in the development of this work. Particularly, we are indebted to H. C. E. Meyer and S. W. Spielvogel for the progress made by this group, and to A. R. C. Markl for promoting the stress-range concept.

# Actions of the ASME Executive Committee

## *At a Meeting in Columbus, Ohio, April 29*

A MEETING of the Executive Committee of the ASME Council was held in the Deshler-Wallick Hotel, Columbus, Ohio, April 29, 1953. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall there were present: H. E. Martin, A. C. Pasini, E. S. Theiss, and W. F. Thompson of the Committee; E. W. O'Brien, past-president; L. J. Cucullu and R. L. Goetzenberger, directors at large; S. R. Beitler; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary. The following items were of general interest:

### Vice-President Region VIII

Clifford H. Shumaker, secretary, Region VIII, was recommended by Region VIII to succeed Harry R. Pearson as vice-president of that Region until the next election, Nov. 30, 1953. In order that Mr. Shumaker may attend the Los Angeles Semi-Annual Meeting as a member of the Council, it was voted to submit his name to the Council by letter-ballot for appointment to this office, letter-ballot to close June 1, 1953.

### Mexico City International Meeting

Upon recommendation of the Board on Technology, the Committee voted approval of an international meeting to be held in Mexico City in 1954, during March. The exact date is yet to be determined.

### New Subsections

Establishment of two new subsections was approved. They were: Mid-Hudson Subsection, including counties of Dutchess, Orange, Putnam, Ulster, and Sullivan; and Long Island Subsection including Nassau and Suffolk Counties.

### Formation of Sections

The Committee voted to approve a revision of the Policy for Formation of Sections, Subsections, and Groups.

### Certificate of Award

Upon completion of his term a certificate of award will be granted to William L. Boswell, now serving as chairman of the Plainfield Section, 1952–1953.

### ASME Space Requirements

It was reported that a letter was sent to United Engineering Trustees, Inc., informing them that ASME space requirements in any proposed new building will be 20,000 sq ft in 1960 and 25,000 sq ft in 1965.

### ASCE Certificate of Appreciation

It was reported that the American Society of Civil Engineers has sent to ASME, as well as to all engineering societies participating in the 1952 Centennial of Engineering, a Certificate of Appreciation: "for its part in the Celebration of the Centennial of Engineering—this united effort demonstrates the importance of the art of engineering to the advancement of civilization."

### EJC Annual Report

The Committee directed that the 1952 annual report of Engineers Joint Council be distributed to the ASME Sections.

### Special Committee

ASME has been requested by the Secretary of Commerce to designate a representative to serve on a committee "to evaluate the functions of the Bureau of Standards." It was reported that James W. Parker, Ann Arbor, Mich, past-president ASME, has been appointed as the ASME representative.

### Deaths

The following deaths of former Council members and Honorary Members were noted with deep regret: John Hunter, Feb. 5, 1953—Manager, 1913–1916, vice-president, 1917–1919; Gano Dunn, April 10, 1953—Honorary Member; and Lewis F. Moody, April 18, 1953—Honorary Member, Director at Large, 1946–1948.

### Appointments

The following presidential appointments were confirmed:

E. S. Theiss to inauguration of president, Fenn College, May 9, 1953.

Hamilton L. Stone to inauguration of president, San Diego State College, May 10, 1953.

Adolph Meyer, to centenary celebration, L'École Polytechnique de l'Université de Lausanne, Switzerland, June 11-13, 1953.

## First Joint Conference on Design in Plastics

AN estimated 150 industrialists, designers, and plastics-industry representatives participated in the first joint Conference on Design in Large Thermosetting Plastics Moldings, sponsored by the Society of the Plastics Industry and the Society of Industrial Designers, held at the Engineers' Club, 32 West 40th Street, New York, N. Y., April 15.

Soliciting comments from designers and product manufacturers on materials now in use, members of the Committee on Large Plastics Moldings presented new and improved phenolic and urea thermosetting plastics materials and molding techniques suitable for larger one-piece housings and broader applications in consumer and industrial products. A display of new products in large plastics housings dramatized what is currently being done successfully with these materials.

The trend of discussion was toward larger and larger one-piece molded housings for radio and TV sets, furniture, air conditioners, appliances, and office machines. For such applications, members of the Committee on Large Plastics Moldings pointed out that new techniques now make possible molded housings of strong, durable thermosetting plastics materials weighing up to as much as 60 pounds. And these materials, it was pointed out, cannot rust, will not warp, and are resistant to all common household acids and solvents. They can be cleaned with ordinary soap and water.

## Case Institute to Study Performance of Air Jets

DESIGNERS for Industry Research Foundation, a nonprofit corporation, has appropriated a research grant in the sum of $5000 for "A Study of the Performance of Air Jets" to be undertaken at Case Institute of Technology in Cleveland, Ohio.

The study concerns the thermal and flow characteristics of heated and chilled air jets. The grant is intended to help in the study of the basic principles of gas behavior so that the results can be applied to any field where air and gases are subject to the conditions encountered in the study, such as air conditioning, warm-air furnace heating, and the like.

To date there has been a need for better instrumentation in this field, and it is hoped that special instruments needed for these studies can be developed during the investigation at Case. The instruments are needed to measure air velocities under variable operating conditions.

Associated with the project at Case are Prof. G. L. Tuve, Mem. ASME, head of the mechanical-engineering department, Alfred Koestal, and H. G. Elrod, Jun. ASME, both assistant professors in the department of mechanical engineering.

## Manpower Authority Calls for Higher Education in Scientific Age

IN discussing the importance of technological manpower before the annual meeting of the American Institute of Chemists on May 13, T. H. Chilton, chairman of the Engineering Manpower Commission of Engineers Joint Council, indicated that this problem has been too often handled in a merely statistical manner which, he pointed out, encourages the diminution of some of the more important aspects of the situation. In the final analysis, he said, we are not dealing with mere numbers but with men and women, who themselves are giving more and more consideration to the development of their own technological careers.

### 1950—A Crucial Year

"Statistically," he said, "1950 was a crucial and distinctive year because it was then that the record class of engineering graduates was absorbed by industry—and that was before the beginning of the Korean conflict. It also was the year which saw one of the smallest freshman classes begin its collegiate career."

He emphasized that this discrepancy was the result of many things but perhaps most of all to those who associated the demand for technological personnel with the immediate economic state and the immediate military need of the country. Dr. Chilton felt that in doing so, we have tended to overlook the most significant forces behind the ever-growing demand for technological personnel. Among these forces, he listed the growing complexity of modern industry and the consequent demand for technological personnel in a larger employment area where their technological skills are needed for adequate performance.

He also pointed out that in certain industries such people are needed for sales market analysis and similar fields.

The manner in which science must grow is important, he stated, and pointed out that every single new discovery has not been an end in itself but has revealed hundreds of new possibilities that await investigation. Dr. Chilton indicated here that in an industrial structure where the ratio of engineers to gainfully employed workers is approaching one to fifty, the number of gainfully employed workers to the over-all growth of industry provides a fundamental reason for increases in the demand for engineers and scientists.

### Science Education Neglected

One of the reasons for the current shortage in this age of science is the amazing fact that we have neglected science education, especially on the high-school level. Responsibility for this must, to a large extent, be accepted by scientists and engineers themselves because it is too much to expect that people outside of these fields be acquainted with the educational needs of science and engineering. This, he pointed out, is an example of the necessity for engineers and scientists to concern themselves with problems that do not seem to have any direct relation to their own professional interests.

In asserting that engineering and science can do no less than provide for the maximum needs of our country, he indicated that failure to do this may, in time of emergency, lead to measures of governmental control which cannot fail to have undesirable implications for the development of science and engineering.

### Possibilities for Career in Engineering Should Be Stressed

For those who urge caution so as not to overload the engineering and scientific manpower markets, he pointed out significantly that even if proportionately every talented youngster in science and engineering would enter those curriculums, the maximum number of graduates we could have would be in the neighborhood of 45 to 50 thousand, or equal to the class of 1950. He also said that it would be difficult in this age of science, to do a disservice to our talented youth by acquainting them with the possibility for career service and development in science and engineering.

In conclusion, he reiterated the importance of these technological professions, stressing that programs that do not consider the viewpoint of the technological professions must, in this age of science, be unbalanced.

## Philosophy Courses for Engineers

PHILOSOPHY will be required study for University of Detroit student engineers during their last three semesters of work, the Very Rev. Celestin J. Steiner, S. J., president, announced.

Beginning with the fall term, logic, philosophy of life, and moral philosophy will be added to the engineering-class schedule.

According to Dean Clement J. Freund, Fellow ASME, University of Detroit college of engineering, and former president of the American Society for Engineering Education, the University of Detroit is unique in placing this stress on philosophical studies for engineering students.

"It is not enough to educate the engineer in the technological-scientific phases of his profession," Dean Freund stated. "A philosophical background is necessary for the proper employment of those technical and scientific tools, so that the individual can properly develop as a man and a citizen."

"An understanding of philosophical principles is important to all men," said the Hon. Thomas P. Thornton, federal district judge, "but, in an age when scientists and engineers deal in such powerful forces as the hydrogen and atom bombs it is particularly essential that these men have a thorough understanding of their duties and obligations as citizens and men."

Other industrial and judicial leaders endorsed the University's program.

## Education

### Patent Course

THE program for its annual five-day study of current problems in patent law has been announced by the Practising Law Institute for the week starting July 6. The course, part of the Institute's twelfth summer session, will be held in air-conditioned rooms in the Hotel Statler, New York, N. Y.

Consisting of three two-hour sessions and group luncheon meetings daily, the program is designed to keep the alert practitioner abreast both of major developments and the experts' latest methods. Changes effected by the Patent Act of 1952, including internal practice of the Patent Office, will be discussed throughout the course, where applicable.

Among the topics to be discussed are: When does a development involve a joint invention or a collection of separate inventions, may claims legally be as broad as the invention, and so on.

The program includes lectures on patent draftsmanship; determination of prior art; studying patents in preparing for license negotiations and for trial; presenting the evidence in patent cases; problems of proof and strategy in interferences; contributory infringement and various aspects of the "misuse doctrine."

The program also includes a review of continuing developments in trade-mark law by Walter J. Derenberg, former Trade-Mark Counsel, U. S. Patent Office; patent clauses in government contracts, the trend of antitrust decisions, and a description of the Canadian patent system.

A catalog detailing the panel of distinguished lecturers and the contents of the course, as well as other courses in the 1953 Summer Session, will be fowarded upon request. Inquiries should be addressed to the Practising Law Institute, 57 William Street, New York 5, N. Y.

### Scholarships

ESTABLISHMENT of a four-year scholarship at the Manhattan College school of engineering by Dr. D. B. Steinman, PE, noted bridge designer, was announced on March 22, 1953, at the fourteenth Communion Breakfast of the college's engineering alumni at the Hotel Statler, New York, N. Y.

The announcement was made in behalf of Dr. Steinman by Brother Bonaventure Thomas, President of Manhattan College, and by Frederick H. Zurmuhlen, PE, New York City Public Works Commissioner.

The scholarship is a memorial to the late Arthur V. Sheridan, founder and past-president of the NYSSPE, and past-president of the NSPE and, at the time of his death, Commissioner of Public Works of the Borough of the Bronx, N. Y.

### Kellogg Scholarship Plan

A UNIQUE industrial-scholarship plan, by which salaried employees will have the opportunity of obtaining full-tuition grants for undergraduate and graduate study while maintaining their regular base pay, was announced by The M. W. Kellogg Company, subsidiary of Pullman Incorporated.

The Morris W. Kellogg Scholarships, named for the founder of the company who died in 1952, consist of one grant for the pursuance of a master's degree and two for a bachelor's degree each year

The scholarships will be offered annually to selected salaried employees of the company and its subsidiaries, giving them the opportunity to attend full time in an accredited college or university. Candidates will be selected on past scholastic achievement, experience and progress in their jobs, leadership qualities, and future potential.

The M. W. Kellogg Company has also had a Tuition Refund Plan operating for some years to encourage employees to continue their education. Company-sponsored classes conducted by professors from universities and by Kellogg senior engineers are also available in preparation for the Professional Engineering License, or to acquire other specific training desired.

Under the new scholarship plan, employees under 30 years of age who have a college degree and who have been employed by the concern at least two years are eligible for the graduate grant. In this case, the individual selected will be sent to college for one year. Upon satisfactorily completing his studies during that year, the grant will be continued for another year, if necessary, to enable him to win his bachelor's degree.

## ICS Enrolls Six-Millionth Student

SINCE 1891 when the first student was enrolled, International Correspondence Schools, Scranton, Pa., has compiled a noteworthy record of accomplishment. On May 20 a celebration at the school marked the enrollment of the six-millionth student. Paul B. Eaton, a Director and Fellow ASME, represented the Society at the celebration.

"The best assurance for our national growth lies in the self-propelling character of our people: Ambition, self-help, self-improvement," said T. W. Tice, president, ICS. For 62 years ICS has been a symbol and a demonstration of those traits. ICS has made it possible for ambitious workingmen and women to train and educate themselves for advancement. More than 3300 national industrial concerns, including engineering companies, use ICS training programs.

Several distinguished members of ASME at one time or another wrote texts for ICS. The new advisory member of the ASME Publications Committee from Region III, W. N. Richards, is employed by ICS as director of mechanical-engineering schools and assistant to the dean of the faculty of ICS.

The honor roll of distinguished graduates of the school includes such famous names as George A. Blackmore, Eddie Rickenbacker, John C. Garand, Charles R. Hook, Harry W. Morrison, Ray C. Newhouse, and Clyde C. Farmer.

## Engineering Societies Personnel Service, Inc.

*These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.*

| New York | Chicago | Detroit | San Francisco |
|---|---|---|---|
| 8 West 40th Street | 84 East Randolph Street | 100 Farnsworth Ave. | 57 Post Street |

### Men Available[1]

**Mechanical Engineer,** BSME, 31, married; three years' experience in machine design. Three years' experience in machine-shop practice. Desires position with progressive concern in design, planning, and development. Me-965.

**Mechanical Engineer**, 37, Registered PE, with heavy construction, operation, testing, maintenance, and design-supervision background. Mechanical and electrical education. Desires position in plant engineering, industrial power plant, or utilities. Me-966.

**Mechanical Engineer**, 30 years' technical and practical experience in product engineering and administration, responsible for die, fixture, and tool design; broad ideas in the application of modern methods, original ideas which have proved successful, cost-conscious, interesting background. Available two to four weeks after agreement reached. Me-967.

**Director of Engineering,** MSME, PE, 20 years' diversified experience in research, product development, production, management, and technical sales in sheet-metal fabrication, heating, and fuels. Desires management position in manufacturing or technical sales. Me-968.

**Mechanical Engineer and Metallurgist,** doctor's degree, 49, single, excellent background and experience, seeks suitable position. West Coast location preferred, but no limitation. Available in 30 days after agreement. Me-969-535-D-1.

### Positions Available

**Machine Designer,** at least eight or 10 years' experience in the design of special automatic machinery. $8000–$12,000. Md. Y-8494.

**Chief Mechanical Engineer,** 35–45, at least 10 years' textile-machinery design, development

[1] All men listed hold some form of ASME membership.

and production experience, to be responsible for design analysis, product development, liaison with production and field application, etc. $14,000, plus bonus. Southeast. Y-8523.

**Industrial Engineer,** 30-35, mechanical or industrial graduate, at least five years' experience covering production planning and scheduling, time-study, methods, layout, materials handling, quality control, standards, incentives, surveys, and report writing for consulting firm. $7000-$9000. Considerable traveling in northeastern U. S. Headquarters, New York, N. Y. Y-8531.

**Engineers.** (*a*) Chief mechanical engineer, 32-40, for manufacturer of precision-metal products typical of component parts for the automotive and heavy-machinery industries. Should be a college graduate in mechanical engineering. Knowledge of powder metallurgy important. Position includes full technical and administrative responsibility for both the development and design of new or improved production equipment and the process-engineering function. (*b*) Manager, product development and design, 32-40, graduate in metallurgical or mechanical engineering, for manufacturer of precision-metal products. Will be responsible for the material development and the mechanical design of products to satisfy customer-application requirements. Midwest. Y-8534.

**Systems Engineer,** 30-40, seven to 10 years' experience in design or development of hydraulic-control systems or in the application of the principles of hydraulics and flow to complete systems. Experience in high-pressure air systems desirable. Should have two or three years' experience in a supervisory capacity. New York, N. Y. Y-8535.

**Engineers.** (*a*) Staff industrial engineer, 32-42, industrial graduate, with cost accounting, statistical evaluation, production methods, and materials-handling experience in paper, plastic, or wood-products fields. Considerable traveling to plants in East and Midwest. $8000-$9000. (*b*) Industrial engineer, industrial, mechanical, or chemical graduate, with time-study, standards, statistical-quality control, and materials-handling experience for chemical-products manufacture. $5500-$7000. Mass. (*c*) Industrial engineer, 28-40, industrial graduate, with time-study, methods, quality-control, automatic, and special machinery experience in laminated-products fields. $7000-$7500. Midwest. Y-8538.

**Engineering Supervisor,** 32-45, preferably graduate, to take charge of plant engineering and drafting forces in an aluminum-reduction plant. Should have had minimum of 10 years' experience in industrial work, including about four years' supervision in design. Experience should primarily be mechanical, but include some work in structures, foundations, or drainage. Salary open. Give salary when making application. Prefer residents of southeastern U. S. Y-8547.

**Mechanical Engineer,** five to 10 years' experience on the installation of steam-generating equipment, plumbing, piping, etc. Single status; one-year contract. $9880. Labrador. F-8552.

**Mechanical Engineer—Development,** preferably 30-40, engineering graduate, with minimum of BS degree, or minimum of six years' experience in product design or development. Under direction will lay out, analyze, and detail experimental mechanisms, and components. Interpret research and performance data, and translate into simple functioning models. Develop, test, and improve mechanisms into finished-product designs. Devise test apparatus to yield research data. Analyze force and energy systems. $6000-$7200. Conn. Y-8559.

**Assistant to Chief Mechanical Engineer** in charge of heating, air conditioning, and ventilation. Work includes industrial, commercial, and institutional buildings, including some power-plant work as well as regular mechanical equipment of buildings. Should be college graduate, seven to eight years' experience in this field. Conn. Y-8566.

**Engineers.** (*a*) Technical writer, group leader, mechanical or electrical, to take charge of project in preparing maintenance manuals. Must understand maintenance techniques and large equipment such as heating, ventilating, and lighting, etc. $7500-$8000. (*b*) Technical writer to work under supervision, but with above maintenance technique, background, and experience. General specifications writing on industrial equipment considered. $5400. New York, N. Y. Y-8569.

**Mechanical Engineer,** preferably with knowledge of military specifications, for company engaged in research, development, and production of mechanical and electrical equipment, primarily for the U. S. Navy. New York, N. Y. Y-8592.

**Engineers.** (*a*) Engineer for packaging-and-closure automatic-machine design. Must have basic mechanical-engineering education with some experience in machinery field. (*b*) Engineer for research work in plastic molding. Must be mechanical engineer or the equivalent experienced in the field of plastics either in the design of molds or preferably working with molding machines. $5500-$7500, depending on experience. Pa. Y-8598.

**Tool Engineer,** 30-45, mechanical-engineering training and at least five years' experience in tool-design and production fields, to design tools for production of synchros, small motors, and other rotating components. $6500-$8500. New York metropolitan area. Y-8599.

**Production Engineers,** 30-45, mechanical or industrial-engineering training and at least five years' shop experience covering electromechanical devices: (*a*) one to handle plant layout, machine-tool placement, set up operation sequence; (*b*) one to install and maintain production-control system. $6500-$8500. Long Island, N. Y. Y-8600.

**Factory Manager and Assistant to General Manager,** 40-50, mechanical degree, for manufacturer of automatic presses and progressive dieing machines. Should have extensive experience in heavy-machinery manufacturing, possess good working knowledge of functions, and relationships of sales, engineering, purchasing, accounting, and labor-relations departments. Salary open. New England. Y-8614.

**Engineers.** (*a*) Field sales manager, 35-45, mechanical degree, for manufacturing of automatic presses and progressive dieing machines. Should have extensive selling experience in heavy machinery or comparable line. Possess good working knowledge of functions and relationships of sales and engineering. $9000-$10,000. (*b*) Sales engineer, 27-37, mechanical degree, some sales experience, to analyze requirements for, and installation and servicing of, special machinery; handle foreign and domestic correspondence. Good opportunity; company will train. To $6000. New England. Y-8615.

**Chief Tooling Engineer,** five years' or more experience in tooling of sheet-metal products. Knowledge of sheet-metal fabrication. Will supervise and direct all phases of tool engineering, procurement of tools, machine tools, and special equipment. Some deep-drawing operations, for manufacturer of major appliances. $7500-$9000. Company will pay placement fee. Iowa. T-9892.

**Manufacturing Engineer,** 30-40, at least five years' experience in metal-fabrication castings, stampings, and machine shop. Knowledge of optics helpful. Will be responsible for converting designs of photomechanic equipment into pilot models and manufactured products for a manufacturer of engraving equipment. $6000-$6500. Employer will negotiate placement fee. Ill. R-9844.

**Administrative Engineer,** up to 30, at least one year's experience in machine tools, either sales or design. Will be engineering and administrative assistant to sales manager, doing some liaison between sales, engineering, and customers and also handling sales correspondence. Inside job for a manufacturer. $5200. Company will refund placement fee after six months Ill. R-9869.

**Design and Development Engineer,** over 30, mechanical graduate desired, five years' experience in general machine and tool design. Knowledge of sheet-metal fabrication. Will do design and product development on tubular furniture. Company has 500 employees and can use men at various levels. Good opportunity for rapid advancement. $6500-$12,000. Company will negotiate placement fee. Western suburb. R-9884.

**Industrial Engineer,** up to 40, three years' experience in general industrial engineering. Knowledge of process plants. Duties include methods, processing, time study, standards, and general industrial engineering for a multiple-plant chemical and mineral-treating company. Must be citizen of U. S. Up to $9600. Considerable traveling. Ill. R-9907.

## Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after June 25, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

*For Member, Associate, or Junior*

Anderson, Arthur B., Norwood, Pa.
Ball, Donald A., East Orange, N. J.
Baniak, Edward A., Beacon, N. Y.
Barkers, Joseph E. San Francisco, Calif.
Barnett, George J., Pasadena, Calif.
Bertino, Romolo B., Melvindale, Mich.
Bloom, Raymond R., Peoria, Ill.
Boardman, Stanley, Glenolden, Pa.
Bongas, James S., Oklahoma City, Okla.
Brown, George J., Grosse Pointe Farms, Mich.
Bucus, Rudolph Zania K., Woodbury, N. J.
Burzi, Guido, Bucaramanga, Colombia, S. A.
Campbell, Allan N., Town of Mount Royal, P. Q., Can.
Castro, Salvador, Levittown, Pa.
Chapman, Frank M., Savannah, Ga.
Ciranna, Thomas P., Denison, Texas
Considine, John M., Savannah, Ga.
Crow, Marshall T., Columbia, S. C.
Cutler, Jerome, Chicago, Ill.
Dalal, Hoshang F., Karachi, Pakistan
Dandelake, James, Jacksonville, Fla.
Darmstadt, Robert M., Woodbridge, N. J.
denTex, Karel, Poughkeepsie, N. Y.
Digby, Charles W., Bay City, Mich.
Disón, James R., Jr., Indianapolis, Ind.
Dubus, Gus R., Jr., Savannah, Ga.
Engquist, Emil B., Chicago, Ill.
Etherington, Harold, Hinsdale, Ill.
Everette, Richard, Oak Ridge, Tenn.
Ewart, John M., Beverly, Mass.
Ferrara, Peter, New York, N. Y.
Foster, Seymour R., Buffalo, N. Y.
Frank, Harry J., Philadelphia, Pa.
Fraser, Joseph R., Butler, N. J.
Fried, Robert P., Staatsburg, N. Y.
Fuller, Arthur L., Bognor Regis, Sussex, England
Gair, Kenneth B., Poughkeepsie, N. Y.
Gaus, Joseph N., Holicong, Pa.
Gillerman, Joseph B., University City, Mo.
Godfrey, John W., Lockport, N. Y.
Goodell, Paul H., Detroit, Mich.
Greene, George H., Johnstown, Pa.
Guiliani, Edward R., Poughkeepsie, N. Y.
Gupta, Arun Kumar, Jadaypur Colony, Calcutta, India
Haines, John E., Minneapolis, Minn.
Hall, Albert C., Pontiac, Mich.
Halvarson, Erik H., Flushing, Mich.
Hayek, Anthony G., Ordsall, Tetford, Notts., England
Heavey, William F., Jr., Warrington, Fla.
Hemeon, J. Russell, Trenton, N. J. (Rt&T)
Hester, Jack G., Pasadena, Calif.
Heyck, Theodore R., Houston, Texas
Hill, Louis E., Corpus Christi, Texas
Holthe, Raymond E., East Peoria, Ill.
Hubbell, Howard H., St. Louis, Mo.
Hunter, Robert K., Jr., Richland, Wash.
Huffer, Harold J., Algonac, Mich.
Iorio, Andrea, Naples, Italy
Johnson, Henry L., Lexington, Ky.
Johnson, Leonard G., Canton, Ohio
Kamman, William F., Ferguson, Mo.
Kell, John A., Cleveland, Ohio
Kistler, Clifford D., Borger, Texas
Klingler, Werner W., Schenectady, N. Y.
Kosar, Halit M., Erenkoy, Istanbul, Turkey
Kostiw, William B., Corona, L. I., N. Y.
Koth, Myron B., Kewaskum, Wis.
Kramer, William E., Pittsburgh, Pa.
Langelund, Jorgen, Detroit, Mich.
Lonardi, Eduardo A., Buenos Aires, Argentina
Macpherson, Charles, Rockville Centre, N. Y.
MacWatt, Kenneth H., Glen Head, L. I., N. Y.
Mainka, Nicholas, Houston, Texas
McCarthy, Richard P., Kansas City, Mo.
McCoy, Millard F., Jr., Agawam, Mass.
McGill, Andrew S., Seattle, Wash.
Meyer, Alfred H., New York, N. Y. (Rt)
Michnya, John A., Conemaugh, Pa.
Milone, Carl J., Omaha, Neb.
Mitchell, Charles J. B., Newark, Del. (Rt&T)
Moroney, Edward W., San Francisco, Calif.
Nogues, Albert, Paris, France
Noll, John H., Jr., Pasadena, Calif.

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UTAH
EVADA
ALSO IN ARIZONA, IT'S YARWAY
YARWAY UNIT TANDEMS
ORNIA
NEW
ME
MEXICO
LOWER
CAL
YARWAY SERVICE GOES ALL THE WAY....

OLVEY, CHARLES L., Piqua, Ohio
OSTERBERG, WILLIAM H., Wahoo, Neb.
PAUL, LESSIE, Oakland, Calif.
PISTER, KARL S., Berkeley, Calif.
POPE, FRED J., Luzerne, Pa.
POTTER, JOHN F., Oskaloosa, Iowa
PLETCHER, THEODORE, White Plains, N. Y.
PURPUS, THEODORE G., Minster, Ohio
RAMSEY, JOHN W., New Orleans, La.
RANKINE, HUGH G., Laurent, P.Q., Can.
REBUFFAT, LUCIO, Naples, Italy
REED, KENNETH E., Chicago, Ill.
RENCK, ROBERT L., Long Island City, N. Y.
RUSSELL, EDGAR F., Erie, Pa.
SARGENT, GEORGE W., JR., Neptune Beach, Fla.
SAYLES, HARRY L., La Grange, Ill.
SCHAPPEL, ROBERT E., Mahwah, N. J.
SCHOFIELD, BRADFORD H., New York, N. Y.
SESSIONS, JEAN H., Whittier, Calif.
SETH, DONALD W., Rego Park, N. Y.
SHAW, RICHARD L., Sidney, Ohio
SHENG, JAMES, Brooklyn, N. Y.
SHERWOOD, ALLAN N., Oradell, N. J.
SILL, ERNEST J., Glendale, Calif.
SIPE, JAMES P., New Bremen, Ohio
SMITH, BENJAMIN A., Rocky River, Cleveland, Ohio (Rt&T)
SPANGLER, DONALD J., Pottsville, Pa.
STARK, ELMER A., Holden, Mass.
STEMSHORN, EDWIN P., St. Lambert, P.Q., Can.
STEVENSON, MATTHEW, Mt. Rainer, Md.
STUCKGOLD, RICHARD, Brooklyn, N. Y.
SYLVAIN, ROBERT A., Palmer, Mass.
THOMPSON, WILLIAM B., Kansas City, Kan.
TIPTON, JOHN J., Michigan City, Ind.
TOLLESON, LOUIS C., Greenville, S. C.
TROWBRIDGE, ROBERT P., Waynesboro, Ga.
TSCHANNEN, ARTHUR W., Denver, Colo.
TULLOSS, JOSEPH C., SR., Haymarket, Va. (Rt)
VAN NESS, BARTOW, JR., Baltimore, Md.
VEITEL, ROBERT DEAN, Milwaukee, Wis.
VON TURKOVICH, BRANIMIR F., Champaign, Ill.
WADDELL, JOHN D., Centerville, Iowa
WANS, IAN, London, England
WARMFLASH, SCHUYLER, Bronx, N. Y.
WATTER, MICHAEL, Philadelphia, Pa.
WAYNE, PETER J., Wilmington, Del.
WESSON, ROBERT W., St. Albans, W. Va.
WILLIAMS, ARTHUR J., JR., Whittier, Calif.
WINER, BERNARD B., East Pittsburgh, Pa.
YUEN, PETER, Oakland, Calif.

CHANGE IN GRADING

*Transfers to Member and Associate*

BANERIAN, GORDON, Monrovia, Calif.
BARTLETT, JOHN M., JR., Kingston, N. Y.
BROWN, HERBERT K., Brookline, Mass.
BUKOWSKI, HENRYK J., Central Falls, R. I.
CHRISTENSEN, HARVEY D., Corvallis, Ore.
ENGLUND, JAMES S., Pullman, Wash.
FARRELLY, FRANK W., Merrick, N. Y.
FLOOR, URBAN, Roscoe, Ill.
GROSS, HERBERT C., JR., Media, Pa.
HAUSMAN, LAURENCE L., Tucson, Ariz.
HOLLER, HAROLD G., Milwaukee, Wis.
JEKGER, EDWARD W., Ames, Iowa
KALBEL, CHARLES S., Wilmington, Del.
KOERWER, RICHARD J., Port Washington, L. I., N. Y.
LERNER, JULIUS, Drexel Hill, Pa.
LOWTHER, W. GLYNN, Port Arthur, Texas
MENKE, JOHN R., White Plains, N. Y.
MOSKOFF, MICHAEL C., Euclid, Ohio
PEARSON, JOHN EDWIN, Urbana, Ill.
RHODES, ARTHUR W., South Charleston, W. Va.
RICHTER, FREDERICK H., New York, N. Y.
SCHWARZ, HANS, Schenectady, N. Y.
SHEDLOCK, WALTER F., Albuquerque, N. Mex.
SMALL, RAMOND E., Cincinnati, Ohio
SMITH, PETER A., Long Beach, Calif.
SNYDER, WILLIAM E., Richmond, Va.
STRYKER, EDGAR H., Berkeley, Calif.
TRIBUS, MYRON, Ann Arbor, Mich.
WALTER, DELTON E., Seattle, Wash.
WAN, CONRAD C., Dallas, Texas
WILSON, ROBERT C., Massillon, Ohio
WINSLOW, RICHARD G., Arcadia, Calif.
WOODARD, CLARENCE J., San Gabriel, Calif.
WOODHULL, ELLIOTT H., Norwalk, Conn.
ZASLER, JACK, Oak Ridge, Tenn.

*Transfers from Student Member to Junior* .... 460

## Obituaries

### Lyman Daniel Adams (1888–1953?)

LYMAN D. ADAMS, whose death was recently reported to the Society, was vice-president, Associated Spring Corp., Bristol, Conn. Born, Hartford, Conn., Jan. 17, 1888. Parents, Louis F. and Anna V. (Heintz) Adams. Education, high-school graduate. Married Clare J. McFetridge, 1914; son, Robert L. Assoc-Mem. ASME, 1917; Mem. ASME, 1924.

### Luis Hamilton Bartlett (1895–1953)

LUIS H. BARTLETT, director, school of chemical engineering, Oklahoma A&M College, Stillwater, died Feb. 16, 1953. Born, San Diego, Calif., Jan. 12, 1895. Parents, Ara A. and Mary E. (Hamilton) Bartlett. Education, BS(ChE), University of Tennessee, 1934; MS(ChE), 1935; PhD, University of Texas, 1943. Married Anne Marie Edelmann, 1937. Author of "Handbook of Refrigerating Engineering"; contributed articles to experimental station bulletins and other technical journals; and held many U. S. Patents. Mem. ASME, 1943. Survived by wife.

### Charles Arthur Booth (1876–1953)

CHARLES A. BOOTH, executive vice-president, Buffalo (N. Y.) Forge Co., died Jan. 31, 1953. Born, Southbridge, Mass., Dec. 31, 1876. Parents, William and Catherine W. (Dole) Booth. Education, Worcester Academy; BS, Worcester Polytechnic Institute, 1898. Married Mabel L. Morse, 1902 (died 1907); children, Theodore H., William W. (died 1937). Married 2nd, Gertrude T. Pratt, 1911. Mem. ASME, 1909. He served the Society on the local section committees and on Power Test Code Committees No. 10 and No. 11. He was active in the organization of the National Association of Fan Manufacturers. He was a past-president of the organization and held other offices. Survived by wife and son, Theodore H., Mem. ASME.

### Howard Haye Brown (1884–1953)

HOWARD H. BROWN, editor, *Marine Engineering and Shipping Record*, and a director, Simmons-Boardman Publishing Corp., New York, N. Y., died March 26, 1953. Born, Penacook, N. H., June 15, 1884. Parents, Edmund H. and Mary Belle Brown. Education, BS, Massachusetts Institute of Technology, 1906. Married Miriam C. Carman, 1923. Jun. ASME, 1908; Mem. ASME, 1925. He was for 20 years editor of the Transactions of the Society of Naval Architects and Marine Engineers; in 1933 he became a vice-president of the society and honorary life vice-president in 1947. Survived by wife; a daughter, Mrs. Nancy Van Gulden; a sister, Helen L. Brown, Concord, N. H.; and three granddaughters.

### Thomas Church Brownell (1898–1953)

THOMAS C. BROWNELL, associate professor, University of Miami school of engineering, died Feb. 11, 1953. Born, Providence, R. I., Oct. 14, 1898. Parents, Ernest H. and Annie May (Angel) Brownell. Education, BS, U. S. Naval Academy, 1921. Married Florence M. Muser; daughter, Betsy. Mem. ASME, 1946.

### George Milton Chenoweth, Jr. (1902–1952)

GEORGE M. CHENOWETH, JR., owner, Chenoweth Machine Co., Hastings, Mich., died Oct. 11, 1952. Born, Baltimore, Md., Jan. 5, 1902. Parents, George M. and Clara (Lehners) Chenoweth. Education, graduate, Newark Technical School, 1934. Married Athelene Sesselman, 1922. Mem. ASME, 1939. Survived by wife and son, George M., 3rd.

### Kenneth Marvin Colline (1922–1953)

KENNETH M. COLLINE, mechanical engineer, Minnesota Mining and Manufacturing Co., St. Paul, Minn., died in Minneapolis, Jan. 5, 1953. Born, Bethel, Minn., Jan. 5, 1922. Parents, Henry and Edna (Engren) Colline. Education, BME, University of Minnesota, 1950. Married Muriel Irene Mauren, 1951. Jun. ASME, 1950. Survived by wife; father; four brothers, Elwood, Norman, Harvey, Raymond; and three sisters, Elvida, Mrs. Richard Miller, Mrs. Floyd Kober.

### Glenville Arthur Collins (1882–1952)

G. A. COLLINS, consulting mechanical and mining engineer, Santa Barbara, Calif., and Vancouver, B. C., Can., died in November of 1952. Born, Clarks Falls, Conn., Sept. 21, 1882. Parents, Francis W. and Alice V. (Burdick) Collins. Education, three years, Colorado College. Married Enid Jones, 1905; children, Grenold, Richard G. Mem. ASME, 1938. Author of numerous articles on dredging published in technical journals and held patents on the Collins water-tube boiler, accessories on power plants, dragline-dredge designs, and mining machinery.

### Adolf Wilhelm Doderer (1901–1952)

ADOLF W. DODERER, mechanical engineer in charge of die design and press work, Globe Union, Inc., Milwaukee, Wis., died July 17, 1952. Born, Stuttgart, Germany, May 24, 1901. Parents, Wilhelm and Marie Doderer. Education, ME, Technische Hochschule, Stuttgart, 1924. Naturalized U. S. citizen, Flint, Mich., June 11, 1935. Married Gertrud A. Kielberg, 1929. Mem. ASME, 1938. Survived by wife and daughter, Eugenie.

### John Holger Gillies (1905–1953)

JOHN H. GILLIES, mechanical engineer, Ohio Edison, Akron, Ohio, died Jan. 21, 1953. Born, Stavanger, Norway, June 8, 1905. Parents, John J. and Marguerita (Bjorensen) Gillies. Education, BS, Dalhousie University, Halifax, N. S., Can.; MS, Temple University, Philadelphia, Pa., 1932. Naturalized U. S. citizen, Philadelphia, Pa., 1931. Married Katharyne I. Sullivan. Mem. ASME, 1949. Survived by wife.

### Archibald N. Goddard (1872–1953)

ARCHIBALD N. GODDARD, founder and chairman of the board of directors, Goddard and Goddard Co., Detroit, Mich., died Feb. 24, 1953, in Key West, Fla. Born, Worcester, Mass., Nov. 28, 1872. Parents, Emmons A. and Mary (Muzzy) Goddard. Education, BA, Worcester Polytechnic Institute, 1899; hon. DE, 1949; hon. DE, Wayne University, 1944. Mem. ASME, 1913. Married Mary M. Goddard (died 1943). Survived by second wife, Beatrice Orr Goddard; and four children, Eloise O., Detroit, Mich.; Miriam G. Bronson, Toronto, Ont., Can.; Emmons A., Mem. ASME, Birmingham, Mich.; Lewis H., Plymouth, Mich.

### William Edgerly Hussey (1873–1953)

WILLIAM E. HUSSEY, retired mechanical engineer, Northport, N. Y., died Feb. 2, 1953. Born, New York, N. Y., Oct. 15, 1873. Parents, Levi and Mary A. Hussey. Education, ME, Stevens Institute of Technology, 1898. Married Florence A. Becker, 1901. Mem. ASME, 1904.

### Henry Olin Jackson (1892–1953)

H. OLIN JACKSON, treasurer, general manager, Great Falls Bleachery and Dye Works, Inc., Somersworth, N. H., died Jan. 6, 1953. Born, Southbridge, Mass., June 27, 1892. Parents, Henry J. and Carrie Jackson. Education, BS(CE), Tufts College, 1914. Married Gertrude Clemence, 1916; children, Robert C., Richard C. Assoc-Mem. ASME, 1923; Mem. ASME, 1924.

### Thomas Conway Kelly (1875–1952)

THOMAS C. KELLY, retired consulting engineer, Cincinnati, Ohio, died Dec. 15, 1952. Born, Georgetown, Ky., July 12, 1875. Parents, James Y. and Ruth (Smith) Kelly. Education, BS(ME), Kentucky State University, 1897; ME, 1906. Married Cora Davenport, 1899. Author of several articles on press fits and held patents on drying machines. Mem. ASME, 1914. Survived by wife.

### Richard Knight LeBlond (1864–1953)

RICHARD K. LEBLOND, founder and chairman, board of directors, R. K. LeBlond Machine Tool Co.; city planning pioneer, and industrialist, Cincinnati, Ohio, died March 17, 1953. Born, Cincinnati, Ohio, April 23, 1864. Parents, Robert E. and Elizabeth (Knight) LeBlond. Education, studied at the Ohio Mechanics' Institute. Married Loretto Heekin, 1896. Mem. ASME, 1900. He was one of the founders of the Cincinnati Section, ASME, in 1912. In 1951, for his contribution to Cincinnati's industrial and economic life, he was honored with the first John T. Faig (Fellow ASME, died March 8, 1951) alumnal award of the Ohio Mechanics' Institute. Survived by wife; two sons, Harold R. and Richard E., Mem. ASME; two daughters, Mrs. William J. Fuller and Mrs. De-Witt W. Balch; two brothers; 16 grandchildren; and 27 great-grandchildren.

### Arthur Burge LeClerc (1904–1952)

ARTHUR B. LECLERC, district engineer, T. C. Heyward Co., Charlotte, N. C., died in December, 1952. Born, Ware, Mass., March 17, 1904. Parents, Joseph F. and Mary E. (Burge) LeClerc. Education, BS(EE), Worcester Polytechnic Institute, 1926. Married Charlotte Kellogg, 1931. Jun. ASME, 1936. He served the Society as chairman, Piedmont Section, 1942–1943. Survived by wife and five children, Mrs. Robert A. Jones, Charlotte M., Mary B., Arthur B., Vincent J.; a brother, Vincent, Attleboro, Mass.; and a sister, Mrs. Donald Culver, Manchester, Conn.

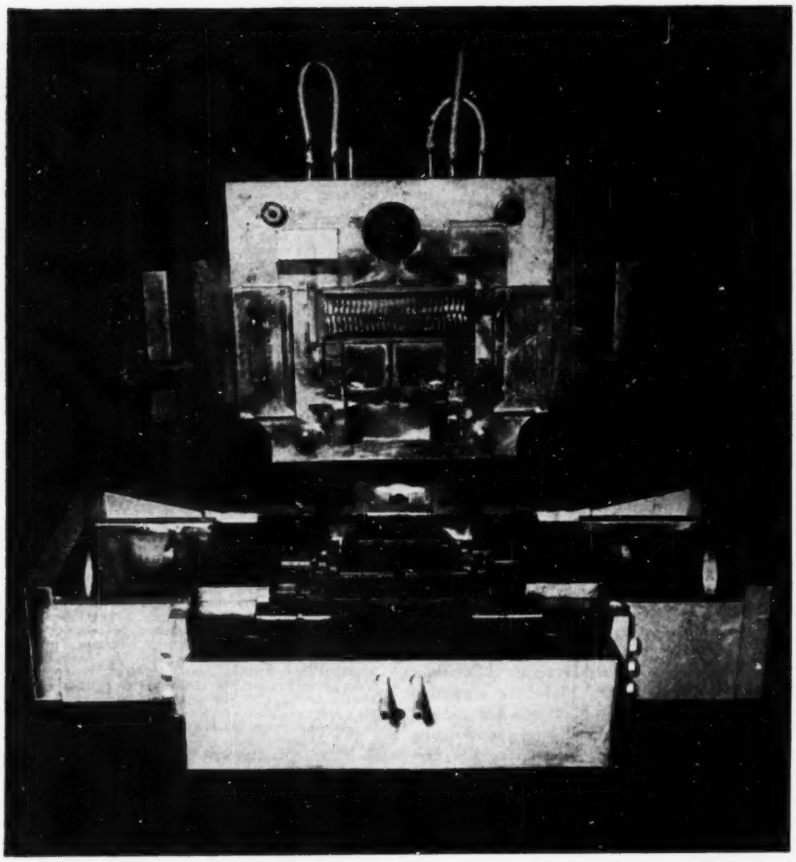
### William McClellan (1872–1950)

WILLIAM MCCLELLAN, chairman of board, Union Electric Co. of Missouri, St. Louis, Mo., died Nov. 14, 1950, according to a report recently received by the Society. Born, Philadelphia, Pa., Nov. 5, 1872. Parents, John and Margaret (Marshall) McClellan. Education, BS, University of Pennsylvania, 1900; PhD, 1903; EE, 1914. He was dean of Wharton School, University of Pennsylvania, 1916–1919. Married Caroline May Stroup. He contributed many articles to technical journals and before technical societies. Mem. ASME, 1905.

### William John Michener (1886–1952)

WILLIAM J. MICHENER, mechanical engineer,

(*ASME News continued on page 528*)



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W&D 3724

Day and Zimmermann, Inc., Philadelphia, Pa., died Sept. 26, 1952. Born, Philadelphia, Pa., May 18, 1886. Parents, John M. and Elizabeth (Prickett) Michener. Education, graduate, machine design, Drexel Institute, 1906; CE, University of Pennsylvania, 1913. Married Mary Walton Coles, 1920. Mem. ASME, 1951. Survived by wife and son, Leslie M.

### Florian George Miller (1905–1952)

FLORIAN G. MILLER, patent attorney, Erie, Pa., died Feb. 29, 1952. Born, Erie, Pa., Aug. 14, 1905. Parents, Albert and Helen (Weigand) Miller. Education, BS(ME), University of Michigan, 1929; LLB, George Washington University, 1932; MPL, American University, 1934. Married June Casby, 1941. Mem. ASME, 1950. Survived by wife.

### William Mittendorf (1871–1952)

WILLIAM MITTENDORF, whose death was recently reported to the Society, was combustion engineer, Holmes-Darst Coal Corp., Cincinnati, Ohio. Born, Cincinnati, Ohio, Feb. 22, 1871. Parents, Eberhard and Elisabeth Mittendorf. Education, graduate, Ohio Mechanics' Institute. Married Miss Schmidt, 1897; children, William, Jr., Ethel. Mem. ASME, 1916; Fellow ASME, 1950.

### Edwin Raymond Motch, Jr. (1901–1953)

EDWIN R. MOTCH, JR., president, The Motch and Merryweather Machinery Co., Cleveland, Ohio, died Jan. 22, 1953. Born, Cleveland, Ohio, Feb. 8, 1901. Parents Edwin R. and Ottie (Carpenter) Motch. Education, BS, Yale University, 1924; LLB, John Marshall School of Law, 1937. Married Mary MacBain, 1927. Decorated for military service in European theatre of operation during World War II. Mem. ASME, 1942. Survived by wife and two sons, Ensign Edwin R. Motch, 3rd, USN, and Donald R. M. Motch.

### William Arthur Newman (1889–1953)

WILLIAM A. NEWMAN, chief of motive power and rolling stock, Canadian Pacific Railway, who played an important role in developing the Canadian aviation industry during World War II, died in the Western Division of the Montreal General Hospital, March 6, 1953. Born, Hamilton, Ont., Can., June 29, 1889. Education, BS(ME), Queen's University, Kingston, Ont., 1911; hon. DS, 1952. Married Edna Mary Elizabeth Jakes. He was awarded the C.B.E. in 1946 for his part in Canada's wartime production effort. Previously, in 1943, he was awarded the O.B.E. in the King's Honours List. He was a member of the Engineering Institute of Canada and a Fellow ASME, 1946, and worked on a joint committee of the two societies for their co-operation in international activities. He was a member of the engineering committee for the industrialization of atomic energy with the National Research Council. He was also a member of the board of the Engineering Foundation, 1947–1950, in the United States. In 1948 The American Society for Metals presented to him the distinguished service award. Survived by wife; two daughters, Mrs. James E. Morgan, Mrs. R. M. Dunton, both of Montreal; and four sisters, Mrs. W. A. Fleming, Calgary; Mrs. James Gorman, Vancouver; Mrs. Harold Marshall, Vancouver; and Jean Newman, Little Neck, L. I., N. Y.

### Frederic Emery Oakhill (1903–1953)

FREDERIC E. OAKHILL, vice-president in charge of manufacturing, O-Cedar Corp., Chicago, Ill., died Jan. 27, 1953. Born, St. Louis, Mo., Feb. 26, 1903. Parents, Frederick H. and Alma B. C. (Nolde) Eikenberg (family name Anglicized). Education, 3 years, mechanical engineering, Illinois Institute of Technology; 1 year, factory management and maintenance, Northwestern University. Married Dorothy Primm, 1922; children, Betty Y., Georgette J. (adopted). Married 2nd, Ruth Wilson; children, Patricia J. (deceased), Frederic W., Marguerite J., Marcia R. Author of many technical articles and a textbook; held several patents on machines he designed and improved. Mem. ASME, 194?

### John Castlereagh Parker (1879–1953)

JOHN C. PARKER, who retired in 1949 as vice-president, Consolidated Edison Co. of New York, in charge of research and development departments, died March 23, 1953. Born, Detroit, Mich., April 15, 1879. Parents, John C. and Mary (Dimler) Parker. Education, BS(ME), University of Michigan, 1901; MA, 1902; EE, 1904; hon. DE, 1940; hon. DE, Stevens Institute of Technology, 1935. Married Elizabeth B. Payne, 1910. Assoc. ASME, 1905; Mem. ASME, 1909; Fellow ASME, 1941. Author of numerous papers of a general technical character; held two minor patents for improvements in electrical distribution systems, issued, assigned, but not commercially developed. In World War II he was a consultant to the War Production Board and organized the Office of War Utilities under the Office of Production Management. He also was a consultant to the War Manpower Commission and the Foreign Economic Administration, and took an important part in the World Power Conference. Survived by wife; two sons, John C., 3rd, Dayton, Ohio; Brooks O'C.; daughter, Mrs. Holland N. M. Sherwood; and eight grandchildren.

### Fred Talbot Patton (1903–1952)

FRED T. PATTON, chief engineer, Col-Tex Refining Co., Colorado City, Texas, died in April of 1952, according to a recent report received by the Society. Born, San Francisco, Calif., Feb. 24, 1903. Education, BA(ME), Stanford University, 1924. Author of several technical papers and contributed the section of API Refinery Inspection Manual on Safe Limits for Pressure Equipment. Mem. ASME, 1946. Survived by wife, Dorothy L. Patton.

### Fred Henry Spenner (1910–1953)

FRED H. SPENNER, assistant vice-president, charge of engineering, Scullin Steel Co., St. Louis, Mo., died Feb. 10, 1953. Born, St. Louis, Mo., Oct. 10, 1910. Education, ME (certificate), Washington University, 1936. Held patents on freight-car trucks. Mem. ASME, 1942.

### Russell I. Sutton (1883–1953)

RUSSELL I. SUTTON, retired machine designer formerly with The Babcock & Wilcox Co., Barberton, Ohio, died March 17, 1953. Born, Fowmansdale, Pa., Feb. 9, 1883. Parents, John R. and Leah E. Sutton. Education, high-school graduate; mechanical drafting course, ICS. Married Elizabeth E. Stutsman, 1908. Assoc-Mem. ASME, 1920; Mem. ASME, 1935. Survived by wife; two daughters, Ruth E., Boston, Mass.; Mrs. Stuart Day, Youngstown, Ohio; and two sisters, Mrs. Norma Wood, Mechanicsburg, Pa.; Mrs. Helen Straley, New Cumberland, Pa.

## Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

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Product or service of company........................................................................

Title of position held........................................................................

Nature of work done........................................................................

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# KEEP INFORMED

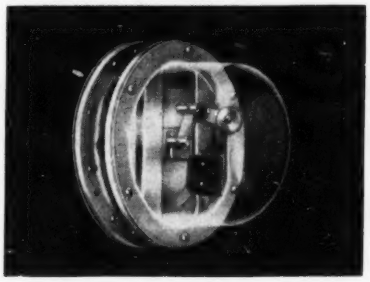
NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

**Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING**

## NEW EQUIPMENT

### Lower Prices for Bin-Level Indicators

New lower prices on certain Bin-Dicators (bin-level indicators) have been announced by George A. Schemm, president, The Bin-Dicator Co. 96-13946 Kercheval Ave., Detroit 15, Mich. The price reduction applies to Bin-Dicator Models A and C with general-purpose Micro switch, which are now priced the same as similar units with mercury switch. The lower prices are possible because of improvements in design and simplification, which at the same time improves the performance of these units, the manufacturer states.



Improvements applying to all models consist of modified frame design which permits easier access to operating mechanism and wiring connections, better and simpler switch installation, and greater flexibility in wiring and conduit installations. Units equipped with the mercury switch, general-purpose Micro switch, and explosion-proof Micro switch also have a new diaphragm back plate which Bin-Dicator declares increases sensitivity and limits diaphragm travel to the minimum necessary for switch actuation.

### Ram and Fork Trucks

Heavy-duty ram and fork trucks, with capacities from 12,000 to 60,000 lb, are the subject of a colorful new brochure released by the Elwell-Parker Electric Co. The free literature contains nearly a dozen action photos showing the handlers in action transporting coils and sheet steel. Various applications within a plant are included.

Eleven models are described; all are detailed according to load capacity and overall dimensions. Copies are available from The Elwell-Parker Electric Co., 4205 St. Clair Ave., Cleveland 3, Ohio.

### O-Rings

The Victor Mfg. & Gasket Co. has announced that it is now marketing a complete line of O-rings made of the firm's Victoprene synthetic rubber compound, for both original equipment and replacement in automotive, aviation, and machinery industries.

The line consists of 87 stock sizes from $^1/_8 \times {}^1/_4 \times {}^1/_{16}$ in. to $15^1/_2 \times 16 \times {}^1/_4$ in. for either moving or non-moving seals, and with 52 additional listings recommended for non-moving sealing applications only. Engineering sales and service in applications on original equipment will be handled by the company through its field engineers. For the replacement market the rings are packaged in cartons and distributed through Victor's industrial bearing and automotive parts jobber outlets.

Victor Victoprene O-Ring Engineering Catalog No. 700 gives all technical data required and is available from the Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill., or from Victor field representatives.

### Synthetic Fibers in Industrial Fabrics

A trend toward the use of synthetic fibers in woven industrial textiles was noted in a statement recently released by Frederic A. Soderberg, Vice Pres. in Charge of Sales, Noone Div. of Kenwood Mills, Peterborough, N. H.

In discussing this growth Mr. Soderberg said, "The unusual properties of the newer synthetic fibers, which have accounted for their tremendous usage in consumer materials, have also been explored concurrently for application to industrial fabrics. Our experimental work in this direction has produced convincing evidence of their value to industry and indicates that entirely new fields are developing for their use. Although we expect natural fibers to continue as materials of great importance, we are certain that many advantages can be gained from 100 per cent synthetic materials or blends of wool, cotton, and synthetics."

Items incorporating the new fibers which have recently been developed by Noone include specially constructed filter blankets and cloths, fume house bagging, and textile machine clothing. An interesting all-synthetic fabric known as Flalon has been produced in conjunction with Burgess-Berliner Assoc., Chicago, for use as padding on all types of presses.

To aid industry further in utilizing synthetics, the Noone Div. of Kenwood Mills is embarking on a major development program. In the year which has elapsed since the merger of the two firms, much new equipment has been installed in the Noone plant. Existing machinery has been modernized and realigned to provide maximum manufacturing efficiency. By adding to their management, sales, and technical staffs, Noone is prepared to tailor fabrics to the specifications of industry. Their facilities include looms for the production of flat and endless materials in virtually any width.

### Pressure-Operated Manually Reset Valve

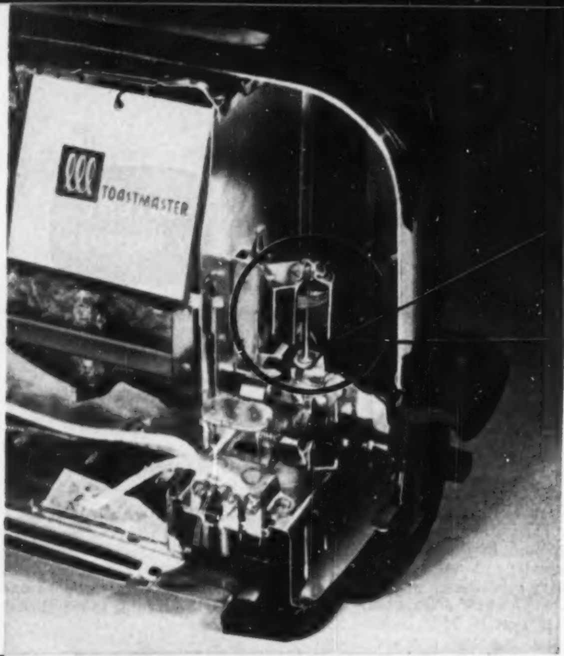
The Automatic Switch Co., Orange N. J., has placed on the market a new pressure-operated, manually reset valve designed especially for use in oil refineries, gas plants of all types, and other plants where hazardous locations make it desirable to avoid electrical connections.

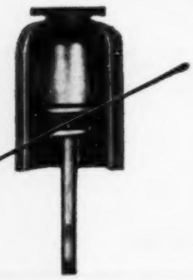
This Asco Valve, described in Bulletin No. 8035, operates on either loss or application of pressure, and requires no electrical power. Bulletin 8035 Valve is available in two-, three-, and four-way construction with the following individual characteristics:

Two-way valve: Furnished in bronze, cast-iron, steel, and stainless steel for water, air, chemicals, oil, steam, and corrosive liquids and gases. Sizes range from $^3/_8$ in. to 6 in. Maximum temperatures: bronze, 350 F; cast-iron, 450 F; steel or stainless steel, 600 F. Maximum pressures range from 600 psi for the $^3/_8$-in. to 5 psi for the 6-in. valves. Standard normally closed valves are manually opened and trip closed upon loss of pressure; optional design to trip closed upon application of pressure. Normally open valves also available.

Three-way valve: Furnished in $^1/_4$ in. through $^1/_2$ in. pipe sizes in bronze, cast-iron, steel, or stainless for air, water, chemicals, oil, steam, and corrosive liquids and gases. Maximum pressures: 500 psi for the $^1/_4$-in. and 150 psi for the $^1/_2$-in. size. Metal or resilient type seats. Optional designs: trip on loss of pressure or trip on application of pressure.

Four-way valve: Sizes range from $^1/_4$ in. to $^3/_4$ in. all-bronze construction. Valves are suitable for pressures up to 250 psi and temperatures up to 300 F. Suitable for control of air, water, oil, and non-corrosive gases and liquids. Optional designs: trip on loss of pressure or on application of pressure.



***Restrictions on brass*** **forced engineers in the Toastmaster Products Division of McGraw Electric Company to find substitute materials for a pneumatic damping device on the toast ejector mechanism. They had been using a cylinder, machined from solid ¾ inch brass rod, and a precision ground brass piston with a connecting rod on a swivel joint. The cylinder head was fitted with a spring and ball check valve. Tolerances on this complicated assembly had to be held within 2 mils to give satisfactory performance for at least 100,000 cycles at 350° F.**

# In pneumatic dampers SILASTIC* simplifies design

## ...saves critical materials

Many substitute materials and designs were tried with disappointing results before one of our technical representatives dropped in with samples of Silastic. Using this heat-stable, rubbery silicone product, Toastmaster's research and development engineers perfected a very simple and durable damper. It consists of an inexpensive drawn steel cylinder, a 1-piece connecting rod, and a flat ring-shaped Silastic piston mounted loosely between two metal cup washers with a simple air leak past the shoulder of the piston.

Tolerances on the new damper are large; the cylinder can be out of round; 86 pounds of mild steel displace 199 pounds of brass per 1000 toasters. *And the new device works better than the more expensive brass assembly.* Such performance proves the usefulness of Silastic as a new engineering material. It retains its rubbery properties and its good dielectric properties at temperatures ranging from below —70 to above 500° F. It is highly water repellent; shows excellent resistance to weathering and to a variety of hot oils and chemicals.

***For more information on the properties or fabricators of Silastic mail this coupon today or phone our nearest branch office.***

*T. M. Reg. U. S. Pat. Off.

**Dow Corning Corporation, Dept. Q-6, Midland, Mich.**

**Please send me:**

- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

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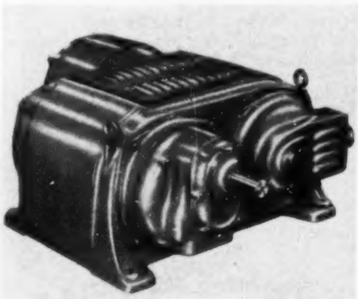
Installation of any of these valves is facilitated, according to the manufacturer, by three design features: (1) Valves will give dependable service mounted in any position; (2) Operating mechanism can be rotated 360 deg; and (3) Valves can be provided with auxiliary switches for indicating lights and electrical control circuits. For special applications where electrical connections are permissible, these Bulletin 8035 Two-, Three-, and Four-Way Valves can be used with a pilot solenoid valve to delay or prevent trip out should a momentary outage occur on the power line to the solenoid. Literature on 8035 Valves will be sent by the manufacturer to anyone requesting it.

**Variable-Speed Motors**

U. S. Electrical Motors, Inc., has announced that its Varidrive Motors are now available in horizontal assembly up to 30 hp, through the addition of a new horizontal frame size, designated 64VE.



The 64VE retains such features of the upright frame-size 64 Varidrives as microspeed indicator, splined Varidisc sheaves, double-cog Varibelts with Autotaut tension control, dual-belt construction, asbestos-protected motor, and normalized castings. This model is also available in combination with the U. S. Syncrogear speed reduction unit, with either single- or double-reduction gearing. Remote controls are available. Varidrive motors are offered in ratings from 1/4 to 50 hp with speed variations up to 10:1 and speeds from 2 to 10,000 rpm. A bulletin containing more information is available from U. S. Electrical Motors, Inc., Box 2058, Terminal Annex, Los Angeles 54, Cal.

**Farm Tap Regulator**

The Rockwell Mfg. Co. has announced the design and production of its new "118" farm tap regulator for high-pressure services. The new regulator has been designed to reduce the pressure on high-pressure transmission lines to a point where pressures reaching isolated customers can be handled safely by a conventional service regulator.

The new "118" operates with inlet pressures ranging up to a maximum of 1000 psi. Interchangeable springs provide four outlet pressures; 5–30 psi, 30–75 psi, 75–300 psi, 200–400 psi. A groove in the diaphragm sealing surface has been engineered into the body casting to retard diaphragm pull at high outlet pressures, and also to afford positive sealing. The new cover has a 1/4-in. tapped vent, with a special vent cap available. Additional information may be obtained from Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

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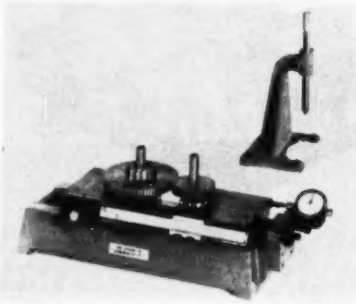
### Needle Bearing Pilot Bushing

A new needle bearing pilot bushing incorporating the sealing principle of the Jergens Pilot Bearing Bushing has been announced by J. G. Jergens Co., Cleveland, Ohio. According to the manufacturer, this new needle bearing bushing is the only needle bushing now in precision manufacture that provides an absolute seal against dirt, coolants, and grit entering the bearing cavity. The manufacturer states that the effectiveness of the needle bushing seal is actually increased as dirt, coolants, and grit enter the outer seal.

The new needle bushings can be disassembled without removing the housing and they protect against thrust loads as well as radial, the company declares. Specification data showing full range of sizes is available from J. G. Jergens Co., 11106 Avon Ave., Cleveland 5, Ohio.

### Gear Tester

George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y., has announced a new model gear tester for spur gears.



The instrument base is a flame-hardened meehanite casting; the floating head rests upon precision steel balls, and contacts a dial gage which is calibrated in 0.0005 in. The slide is held against the gage by an adjustable spring. For measuring center distance a rustproof scale and vernier is furnished, which reads in 0.001 in. The gears to be tested are placed on fixed arbors, or studs. One support is furnished as standard equipment.

### Adjustable Speed Drives

A simplified addition to its line of Thymo-trol packaged electronic adjustable-speed drives has been announced by the General Electric Co.'s Control Dept.

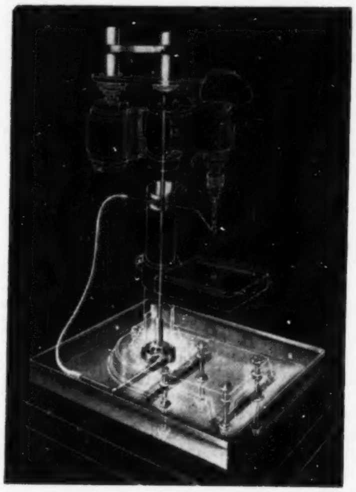
Designed for use on many types of equipment, including testing machines, printing presses, conveyors, variable-volume or proportioning pumps, and machine tools, the new unit is available for $^3/_4$- to 3-hp drives. It offers stepless speed-control, pre-set speed control, and close speed regulation, according to company engineers, and includes the smallest G-E Thy-mo-trol drive panel, measuring $15 \times 18 \times 12^1/_2$ in.

The new electronic drive is offered in standard speed ranges of 5:1 and 20:1, and comes in both reversing and non-reversing forms. It retains many of their features of the larger G-E systems, including dynamic braking and standard overload and undervoltage protection.

The motor will accelerate to and hold any preset speed within plus or minus three per cent regardless of ordinary load changes. The simplified system consists of an anode transformer, electronic control panel, control station, and d-c shunt-wound motor. It operates on 220/440 v, single-phase 50/60 cycles. Dual rating of the anode transformer makes it possible to use either voltage by merely changing primary connections. Special drives can be supplied to operate from other standard power supplies, according to company engineers.

### Coolant Pump for Bench Drill Presses

New compactness and convenience are claimed for a coolant supply unit offered by Wade and Sons, 930 E. Truman St., Independence, Mo.



It can be installed in the hollow column of any popular-make bench drill press, and requires no separate motor. The drill press motor is higher than the coolant supply and thus eliminates the danger of electrical shock. Operating with a half-gallon of coolant of any type, the Wade pump carries the liquid through tubing beneath the drill press. The pan is made of extra heavy-gauge steel and is provided with clips on the sides to hold splash shields when additional height is desired. The pump intake is screened to keep out drillings.

All fittings to adapt the device to all well-known makes of bench drill presses are supplied in the complete kit, with instructions for assembly. Advantages claimed include longer drill life, better size control and finish, faster speeds and feeds, and the elimination of coolant drums, extra motors, and rigging.

### Controlled-Circulation Boiler

The advance in boiler practice during the last twenty-five years is strikingly illustrated by a contract just closed by Combustion Engineering-Superheater, Inc., to furnish the boiler for a new generating unit at the State Line Station of the Commonwealth Edison Co. system. The station is located at Lake Michigan and the Illinois-Indiana border.

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Designed around 1926 and officially placed in service in the summer of 1929, this station attained widespread attention because it contained the largest steam turbine in existence—a 208,000-kw, three-element machine operating at 600 psi, 730 F superheat, with 500 F live steam reheat, and served by six 450,000-lb per hr sectional header boilers. This turbine size has not been exceeded to date, CE reports, although larger machines are on order.

The new cross-compound turbine-generator now on order will be of 191,000 kw—comparable in size to the earlier unit, but it will have only one boiler instead of six. The nominal steam conditions will be 2000 psig and 1050 F primary, 1050 F reheat temperature at the turbine instead of 600 lb, 730 F primary, and 500 F reheat. The boiler will be of the Combustion Engineering controlled-circulation reheat type with a twin furnace, platen-type superheater, and corner firing with tilting tangential burners for steam temperature control. It will be served by eight C-E Raymond bowl mills and have three air preheaters of the Ljungstrom regenerative type. There will be four circulating pumps and the continuous rated output of the unit will be 1,350,000 lb of primary steam per hour, a figure stated to be one-half that of the combined output of the six earlier units supplying about the same turbine capacity. The new boiler is scheduled for operation in the fall of 1955.

### Largest Gear Lead Checker

Designed to check both lead and axial pitch on large helical or herringbone gears, as well as parallelism of teeth on large spur gears, Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich., announces the Michigan "Sine-Line" Model 1248 lead checker, said to be the world's largest.

The Michigan "Sine-Line" lead checker will check both lead and axial pitch on gears from 18 to 48 in. outside diameter, with a maximum face width of 25 in. and a maximum shaft length of 96 in. Either right-hand or left-hand leads may be checked. The machine uses the sine bar principle to check leads from 0 to 80 in. Either manual or power drive is used in its operation. No change in the mounting of the gear is required to check either lead or axial pitch. Gears of varying face widths or diameters, but with the same lead, may be checked without changing the setting of the sine bar.

The machine has a massive cast base for rigidity. The machine consists primarily of two "tables," a transverse table carrying the sine bar, enclosed in the left of the machine, and a longitudinal table which carries the indicator. The sine bar table is arranged to move crossways of the machine at the same time the indicator table moves lengthwise, parallel to the axis of the gear being checked. The sine bar table, when moved back and forth, rotates the spindle upon which the gear is mounted. The adjustable sine bar determines the relationship between the movement of the indicator table and the rotation of the gear being checked. Correct adjustment of the sine bar is determined by a formula.

**For Consulting Engineers**

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### Small-Bore Gage

As a development of its small bore gage, Standard Gage Co., Poughkeepsie, N. Y., has announced complete sets of centering-size disks whereby this gage can measure any bore within its over-all range of $^1/_4$ in. to $^3/_8$ in. Previously this #00 gage had been presented as a "single-hole" gage to be furnished with a centering-size disk proper for the checking of the one dimension to be specified by the user. Now, however, there are available complete sets of extensions covering any dimension from $^1/_4$ in. to $^3/_8$ in., thereby making the gage further useful as a tool room instrument, for certain quality control uses, and as a general purpose gage.

The set consists of 27 centering-size disks mounted on a rectangular plate with the size of each one plainly marked. The disks are interchangeable on the head and lock into position by the action of a clamping nut. Other features of this #00 dial bore gage are the sapphire-tipped gaging plungers and the hard chrome-plated surface of the disk. Indicator graduations are 0.0001 in. While it is expected that the gage will be used to check very close tolerances, it will, however, cover a total tolerance as great as 0.005 in. The gage will check to within $^1/_{16}$ in. from the bottom of the blind hole.

The manufacturer points out that the sets of disks are offered as an optional alternative to the user and that the gage will still be furnished, if desired, with a single disk suitable to the user's specified dimension and tolerance.

### Coolant Filter

Automatic, continuous filtration of water-soluble coolants for individual grinders, hones, and other machine tools is claimed for a new constant-vacuum, endless-belt filter developed by the Industrial Filtration Div. of U. S. Hoffman Machinery Corp.

Called the "Vacu-matic" Filter, the new unit provides automatic, self-cleaning operation, keeps coolant cool and delivers de-watered sludge for easy disposal, according to Hoffman. Because it employs vacuum, rather than gravity, the Vacu-matic is described as four times faster in its filtering operation than previous endless-belt filters.

Two models of the "Vacu-matic" are furnished: one for flow rates of 20 gpm and the other for 40 gpm. Used oil flows by gravity from the machine tool into the Vacu-matic cabinet where a baffled distributor head spreads it evenly across an endless, moving filter belt. This belt is especially woven of nylon, wool, and cotton fibers. A built-in vacuum pump produces a pressure differential in the chamber over which the belt moves. This difference in pressure draws coolant through the belt into the chamber from which it drains into a clean coolant sump. It is recirculated to the machine by the Vacu-matic's built-in clean coolant pump. Solid particles which have remained on the endless belt are carried forward toward the discharge end of the unit. A vibrator loosens this caked residue just before the radius of the discharge-end roller. Particles drop into a removable tote box for disposal.

Complete details, specifications, and dimensions on the Vacu-matic Filter are contained in Bulletin A-915, which may be obtained by writing Industrial Filtration Div., U. S. Hoffman Machinery Corp., 219 Lamson St., Syracuse 6, N. Y.

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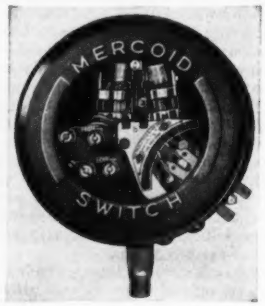
### Pressure Control

The Mercoid Corp. has introduced a new pressure control, called the DA-400 series, which incorporates a single bourdon tube that actuates two independently adjustable magnet-operated mercury switches. A calibrated dial with two outside adjustments is provided for setting the pressures at which each switch operates. The upper pointer indicates the operating point of the high-pressure circuit and the lower pointer indicates the operating point of the low-pressure circuit. The pressure represented by the difference between the two pointers indicates the pressure change between the operation of the switches.




The manufacturer suggests these uses: (1) To close one alarm circuit at high pressure and another at low pressure with both circuits open over the operating range; (2) To operate as an electrical interlock, opening one circuit as pressure rises above and opening the second as the pressure drops below the operating range; (3) To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

The control is available in twelve ranges from 0–30 in. to 300–2500 lb. The electrical capacity of each switch is 20 w, 115 v or 230 v, alternating or direct current, $^{9}/_{10}$ amp at 24 v or less. Bulletin 5P is available from the Mercoid Corp., 4201 W. Belmont Ave., Chicago 41, Ill.

### Remote Liquid-Level Indicator

Easier readings of liquid levels are claimed by a new type face and cover plate on Yarway Remote Liquid-Level Indicators. The raised, transparent face permits the indicator arm to be extended under the cover to a position where it can be viewed from the side as well as the front. This improved visibility makes it possible to check boiler water levels or other liquid levels from most any location in the control room or wherever the Yarway Indicator may be installed.

The indicating mechanism is operated by the boiler water itself. Indicating mechanism is never under pressure. There are no stuffing boxes.

Yarway Remote Liquid-Level Indicators are of the manometric type, with automatic temperature compensation. They are fully approved for use under the new ruling of the ASME Boiler Code Committee as covered in Code Case 1155, which permits the use of two remote indicators in place of one of the high-pressure boiler water level gages on boilers over 900 psi. For full information on Yarway Wide Vision Remote Liquid-Level Indicators, write to the Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.

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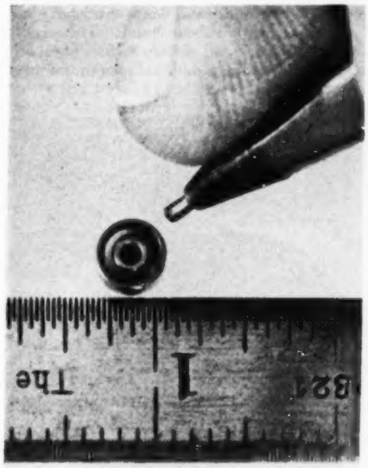
### Miniature Sealed Ball Bearing

According to its maker the smallest sealed ball bearing ever designed, and the newest addition to the RMB Filmoseal series, has been announced by Landis & Gyr, 45 West 45th St., New York 36, N. Y. Measuring 0.1969 in. OD with a bore of 0.0591 in., it is a Conrad-type bearing with deep-groove inner and outer raceways and a ball retainer.



Feature of the bearing is a capillary film of lubricating oil which forms between the tapered outer surface of the inner race and the edge of a precision closure. This film of oil, the manufacturer says, seals the bearing against dirt and moisture, and prevents loss of the lubricant, without any significant increase in frictional torque.

The RMB Filmoseal series includes 11 sizes, ranging up to 0.8661 in. OD. They are recommended for indicating and recording meters, precision instruments, and any small mechanism where low torque and long life with a minimum of attention are desired.

### Corrosion-Resistant Coatings

A recently-developed addition to the Vinsynite group of corrosion-resistant metal coatings has been announced by Thompson & Co., 1085 Allegheny Ave., Oakmont, Pa. Designated as "Vinsynite FS-3," the new product is a stable-type treatment formulated especially for roller coating on ferrous metals. It is yellow in color and when baked as recommended provides outstanding adhesion on ferrous metals and excellent resistance to all types of exposure.

As other types of Vinsynite, FS-3 is intended for use under top coats but will itself protect surfaces for short periods of time. In effect it chemically pretreats the metal and covers it with a thin vinyl primer film in one operation. According to the manufacturer, in addition to its superior adhesion and corrosion-resistant qualities, its use can result in much-increased efficiency of coating operations for a wide variety of steel products, where roller coating equipment is involved in finishing. Other types of Vinsynite are available for dip, spray, and brush coating all metals, including aluminum, steel, and copper, as well as glass and many kinds of plastics. The manufacturer will furnish literature and specifications upon request.

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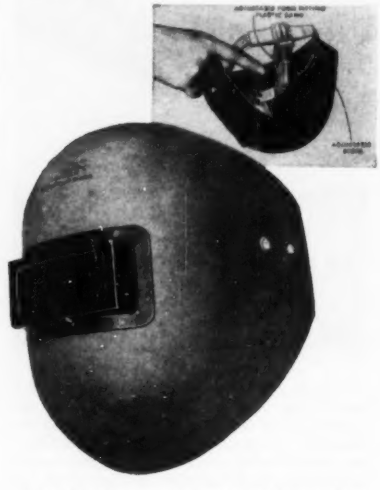
### Arc Welding Head Shield

A new arc welding head shield designed specifically for operator comfort has been announced by The Lincoln Electric Co. of Cleveland, Ohio. The new shield is called the Lincoln Comfort-Shield. The feature of the shield is a permanently pliable head band made of plastic rather than the usual fibre. The adjustable plastic head band fits the head in the same way a hat does, is adjustable to fit both around and over the head, and can be put on with one hand. The plastic does not dry out and curl up as does fibre, but remains soft and pliable, the manufacturer reports.



The shield proper is made with one-piece molded fibre construction. It has wide and deep clearance around the head to permit free circulation of air. The normal chin strap has been eliminated. Adjustable stops on each side of the head band limit the drop of the helmet to any point desired by the welder. The stops prevent the shield from hitting the nose or chin when welding vertical or overhead. The shield takes the standard size 2″ × 4-1/4″ lens and glass.

### A-C Welding Transformer

A new 400-amp single-phase a-c welding transformer with a 60 per cent duty cycle has been announced by the General Electric Company's Welding Department. Designated as G-E Type WK40K, the new welder provides a current range of 40 to 500 amp, and can be used with a variety of electrode sizes for repair, maintenance, and construction work.

According to G-E engineers, the new transformer not only assures quick starting, but also incorporates arc-stabilizing capacitors which make it easier for operators to strike and maintain an arc without popouts. This results in faster travel speeds, fewer "patch ups," and stronger welds, they said.

The extra-wide current range allows the use of this one machine for a wide variety of applications, from light-duty, low-current sheet metal jobs to heavier-duty, high-current industrial work. A range switch enables the operator to change quickly from high to low currents or vice versa.

Other advantages of the new welder are

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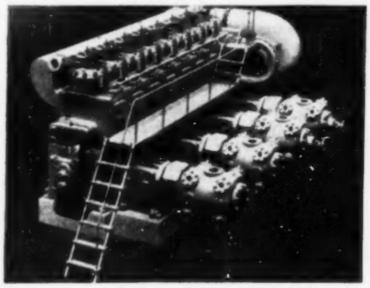
longer coil life, because of silicone insulation, stepless current control permitting accurate adjustment, and built-in idlematic control for protection against electric shock. The new welder is 44 in. high, 22-5/8 in. in diameter, and weighs 355 lb.

**Turbocharged Compressor**

Clark Bros. Co., Olean, N.Y., has announced its Model TRA, said to be America's first turbocharged 2-cycle right-angle gas-engine-driven compressor unit. The Clark Model TRA-8, which develops 1320 brake hp, has eight vertical, in-line cylinders of 14-in. bore and 14-in. stroke, integrally connected to horizontal compressor cylinders.



In addition to the TRA-8, other Clark "Angle" compressors are now available as turbocharged units with comparable increases in power and operating economies. These are some of the features given by Clark for the TRA: (1) Fifty per cent more power than any non-turbocharged unit now built of comparable bore and stroke, with no encroachment on overload carrying ability; (2) Conservatively rated and guaranteed to burn substantially less fuel than any gas-engine-driven compressor now built; (3) Requires 25% less cooling water per BHP than the best non-turbocharged, high-compression, gas-engine-driven compressor now built, even including scavenging air intercooling; (4) Fuel consumption remains practically constant between 70 per cent of load and maximum load; (5) Noise is converted into energy in the TRA; quiet and smooth-operating, no exhaust pulsations; (6) Compact, accessible, 2-cycle in-line design.

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Turbocharging as incorporated in the Clark TRA is a method of converting waste heat into energy. This is done by using the waste heat, velocity, and mass flow of the exhaust gases to drive a radial inflow turbine. The turbine, in turn, is integrally connected to a centrifugal compressor. This centrifugal compressor pumps air for scavenging the power cylinders and also provides air for combustion. Thus, in the TRA no scavenging cylinders are required. The Clark Turbocharger is positively driven by the engine at start-up and on light loads. Under all other load conditions, it operates independently of the engine, its speed automatically conforming to the load placed on the engine.

For additional information on the new Clark Turbocharged Right-Angle compressor, Bulletin No. 130 is available.

### Gear Finishers for Large Gears

Gears up to 15 ft in diameter and with up to 48 in. face width can now be finished more rapidly, to higher accuracies, and at far lower cost, as the result of the introduction of a line of standard vertical large-gear shaving machines, the Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich., has stated. The machines can be used for spur, helical, or herringbone gears, internal or external with or without integral shafts, as used in marine, railroad, power plant, ordinance, and other large gear applications.

Michigan Tool Co. claims this new line provides the following advantages: (1) reduction of costly and time-consuming lappings (2) reduction in finishing time; (3) ability to produce more accurate large gears than by other processes; (4) ability to cut hobbing time by use of multiple thread hobs; and (5) ability to produce gears which will mate automatically.

The Michigan V-series standard machines are available in four models having respectively 48-in., 72-in., 120-in., and 180-in., gear-diameter capacities. They are designed for high versatility and are provided with facilities for mounting of integral gear checking accessories, making it possible to check gears before removal from the finishing machine.

The Michigan V-180, largest of the four gear shavers, will accommodate internal or external gears from 100 in. to 180 in. in diameter. Spur or helical gears, or gears with or without integral shafts are finished on the machine. The machine has a capacity for shaving spur, helical, and herringbone gears 65 in. wide. Floor space is 208 × 210 in. with a height of 166 in.

The V-120 will shave internal or external gears from 60 to 120 in. in diameter. Maximum gear width for spur, helical and herringbone gears is 50 in. The machine is 207 in. long and 147 in. wide, with a height of 148 in. Machine weight is 76,030 lb.

The V-72 has a gear diameter capacity of 20 in. to 72 in. and will shave internal or external gears 50 in. in width. A table hole 18 in. in diameter allows gears with integral shafts up to this size to be shaved.

The V-48 is the smallest of the V-series line, having a gear capacity from 8 to 48 in. in diameter. Hole in table is $12^1/_2$ in. in diameter. It will shave internal gears as well as external gears. Work table on the V-48 is mounted on a pre-loaded taper roller bearing. Maximum gear width for spur, helical, and herringbone gears is 30 in. Base dimensions are 94 × 124 in., height, 126 in. Magnetic chip conveyors are optional equipment on all models.

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All models except the V-48 are available with dual cutting heads. The two cutting heads are independently adjustable for correct angle, and the top head may be adjusted for height. With a herringbone gear each cutter cuts one helix face so that both helices may be cut simultaneously.

The large gears are shaved by means of cutters shaped similar to gears but with the teeth serrated to provide a series of cutting edges. The rotary cutter and gear rotate in mesh with the work driving, but the axes on which the gear and cutter are mounted are not parallel. With this crossing of gear axis and cutter axis, each cutting edge sweeps in a shearing action across some part of the gear tooth face as the gear revolves.

The tables on the three larger models of the V-series machines, which on the 180-in. machine must support a variety of gears weighing up to several tons, are supported by an oil film whose pressure can be adjusted to suit the varying table loads.

Provision is made for mounting a turning tool on the lower cutter head in order to take a cut across the top of work holding fixture, thus insuring a plane surface, for mounting the gear, parallel with the top of the work table. Another design feature of the line of machines is the use of T-slots in the table. This enables fixtures and gears to be mounted in the shaving machine, with absolute concentricity between the shaved gear tooth surfaces and the table bearing.

A further advantage claimed for the hollow table design as well as an inherent advantage of the vertical type of machine design is that the gear can be located in the same position and on the same face that it is located in the previous hobbing machine operation where the gear teeth are generated. Effect of possible shaft deflections is also eliminated with the vertical design.

Maintenance of accuracy to 0.0003 in. in leveling the entire machine is achieved through the use of a strain gage which checks and keeps uniform the strain on each leveling jack, in conjunction with the leveling pads and a spirit level. This gage measures deflection in microinches.

Work table drive motors on the V-72, V-120 and V-180, are 230-volt, d - callowing an infinite choice of table drive speeds from 0.93 to 15.16 rpm on the V-180, 1.29 to 28.62 rpm on the V-120, 3.25 to 72.33 rpm on the V-72, and 15.6 to 186.6 rpm on the V-48. Motors on the V-series are as follows: V-180, 60 hp, 1150 to 1440 rpm; V-120, 25 hp, 1150 to 2300 rpm; V-72, 15 hp, 1150 to 2300 rpm. On the V-48, the work drive motor is AC 220/440 V, $7^1/_2$ hp, 1800 rpm.

### Foundry Shakeouts

Link-Belt Co. has expanded its line of foundry shakeouts with the introduction of a medium-duty foundry shakeout in four sizes, with capacities up to 5000 lb. It is designed for the many foundries producing smaller size castings. This medium duty shakeout is similar in many features of design and construction to the Link-Belt heavy-duty shakeout, which is made in six sizes, with capacities ranging from 10,000 lb to 30,000 lb.

These shakeouts provide fast separation of castings from flasks and molds, hasten reduction of sand lumps, tend to eliminate flask damage, and simplify reclamation of reinforcing rods, gaggers, and sprues. Provision is made for limiting motion during accelera-

tion and deceleration, thus eliminating the hazard of destructive vibration during the critical speed range.

The vibrating mechanism is full-floating and completely enclosed. Amplitude of vibration is controlled by varying segmental weights. Both medium- and heavy-duty models have oversize cartridge-mounted roller bearings. The heavy-duty shakeout has provision for hydraulic removal of bearings. Both shakeouts are available in either horizontal or self-discharging inclined types in all sizes.

Link-Belt heavy-duty and medium-duty shakeouts are described in detail in Book No. 2438, recently released by Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

### Hot-Water Pressure-Relief Valves

The A. W. Cash Valve Mfg. Corp. has introduced a new series of automatic reseating temperature and pressure relief valves, designated "Econo-Therm" Relief Valves, Cash-Acme's Type V series. The valves are designed to serve as both temperature and pressure relieving valves for use in hot-water storage heaters.

The temperature-actuated mechanism, the manufacturer declares, contains no fluids, will withstand high temperatures without deterioration, and will not wear out with use. The Type V series is approved by the American Gas Association. The valves in the series are available in either regular or stem style, and with or without try levers. The regular valve is recommended for ordinary hot-water storage heater installation, the stem valve for electric heaters, insulated tanks, and installations where close nipples cannot be used. Standard factory pressure relief setting is 125 lb, temperature setting 208 F. Other settings may be specified. Further information is in Bulletin No. 297, available on request from the company.

### Refrigerant Compressor

The Frick Co. Waynesboro, Pa., has increased the capacity of its Eclipse compressors by adding a 1200-rpm model to the line. This 9-cylinder compressor has a $5^1/_2$-in. bore and a $3^3/_4$-in. stroke, and requires a 150-hp motor at 1200 rpm.

An oil cooler is provided to reduce crank-case temperatures, and dual stop valves are used, one on each side of the suction strainers

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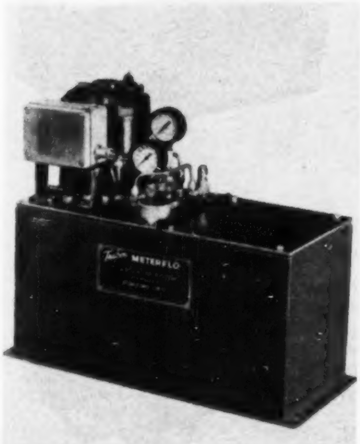
The main suction opening is 6 in. iron pipe size and the discharge line is 5 in. V-belt drive is not included as regular equipment; the manufacturer explains that direct-connected motors will more often be used.

Other Frick Eclipse compressors are built with 3, 6, or 9 cylinders, of $3^1/_2$-in. bore and $4^1/_4$-in. stroke.

### Oil Circulating System

Trabon Engineering Corp., 1814 E. 40th St., Cleveland, Ohio, has developed a new oil circulating system known as "Meterflo." The system utilizes the Trabon positive piston-displacement principle.



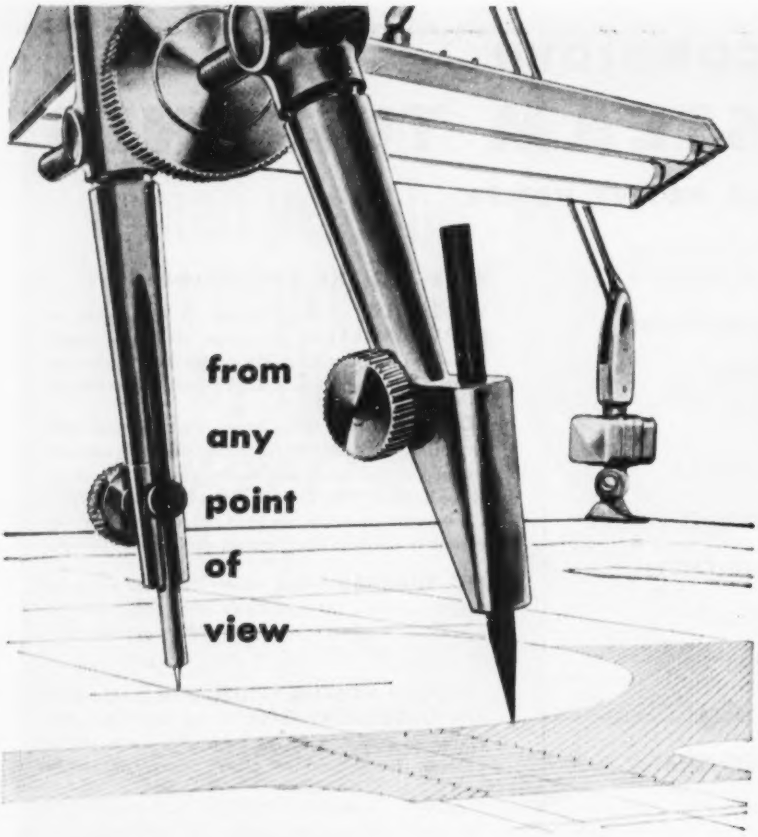
Features of this system include: Flow rates up to 80 cu in. per min; RTP-2000 series rotary-type pump units available in complete range of discharge capacities; pump units with or without sumps include motor, pump, high-low dual-acting pressure switch, cartridge-type filter, pressure gauges, oil-level gauge, and fill screen; sump units include removable baffles for cleaning of tank; Type MXO and MO metering valves to control flow of oil to each bearing in the system.

A pair of continually blinking lights, actuated by flow of oil, are available as optional signal equipment. The high-low pressure switch, connected to the warning lights, permits identification of too-high or too-low pressure, blocked line, low oil supply, or will shut down the machine being lubricated. Bulletin No. 531 contains more information.

### Anchor Nuts

The Kaynar Co., producers of the Kaylock light-weight, high-strength, selflocking nuts and gang channel, announces the introduction of their new F-5000 series, 2-lug floating anchor nuts in the 10-32 and $^1/_4$-in.-28 tap sizes. This new F-5000 series utilizes the same locking device originally introduced in the Kaylock line of self-locking nuts, and are produced in full conformance with the most exacting specifications (including AN-N-5b and AN-N-10a) of the aviation industry.

The Kaylock F-5000 series is produced from tempered spring steel and because of its all-metal construction can be used in applications up to 550 F. Parts are normally furnished cadmium-plated, but are available in other finishes for special applications.





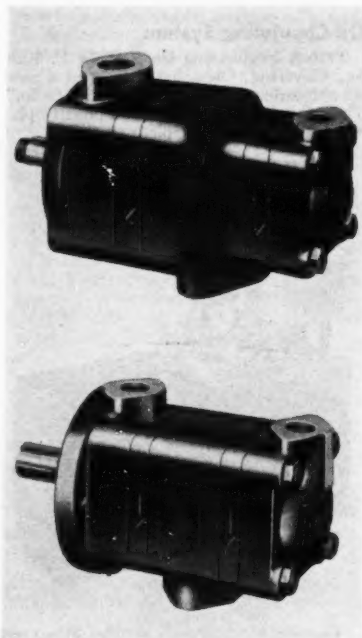






### Double Pumps

Vickers, Inc., has announced two new double pumps, series V-2200 and V-3200, for mobile applications where two independent hydraulic power sources are required. Both series are compact and each consists of two vane-type pumps in a single housing, driven by a common shaft.



The new double pumps are particularly applicable to materials-handling equipment and road and construction machinery for uses such as power steering, in addition to the usual needs. Their basic design is identical with Vickers standard line of mobile pumps. Ten sizes of series V-2200 pumps are available, with any combination of 2-, 5-, 8-, or 11-gpm delivery units. Series V-3200 pumps are made in 16 sizes, with a choice of a 2-, 5-, 8-, or 11-gpm pump at the small end and a 12-, 15-, 18-, or 24-gpm pump at the other. A choice of splined, threaded, or straight keyed shafts and face, flange, or foot mountings is available. Further information is contained in Installation Drawings No. 157591 and 158073, available on request from M. J. Taup, Mgr. Mobile Products Sales; Vickers, Inc.; 1500 Oakman Blvd., Detroit 32, Mich.

### Ball Bearings

The Nice Ball Bearing Co., Philadelphia, Pa., has announced a new line of precision-ground radial bearings. Designated the "C" Series, these bearings are of the solid-race type with ball retainers, and are made in inch dimensions which correspond to established light-duty inch standard sizes. They are designed for light-duty radial, thrust, or combined load applications, and speeds in the neighborhood of 5000 rpm maximum. "C" Series bearings are produced with ground and polished race ways and incorporate chrome alloy balls; they are available without shields, single shielded, or double shielded.

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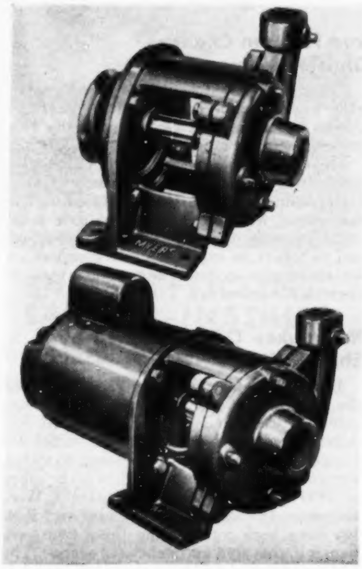
### Centrifugal Pump

"Centri-thrift," a competitively priced line of centrifugal pumps, has been introduced by The F. E. Myers & Bro. Co., 904 South Orange St., Ashland, Ohio. Available in 1/3-, 1/2-, 3/4-, and 1-horsepower sizes, the Centri-thrift line can be used with air-conditioning and laundry equipment and for hot- and cold-water circulation, booster service, cooling systems, lawn and garden irrigation, and other types of liquid transfer, including use as a coolant pump by machine tool manufacturers. The Centri-thrift line is available in either the motor-mounted or belt-driven models.



The new pump is powered by a 3450-rpm capacitator-type motor with built-in overload protection, and will develop heads up to 92 ft with capacities up to 50 gpm, according to the manufacturer. The pump features a corrosion-resistant stainless-steel pump shaft, a removable bronze wearing ring, and a rotary seal which eliminates "packing-box drip."

### Magnetic-Particle Clutch

The Clark Mfg. Co. of Cleveland, Ohio, has announced the development of a magnetic-particle clutch. The Clark Dynamatic Drive is an innovation in magnetic clutches, the company states, because it replaces unstable iron particles with stable particles of stainless steel.

The clutch consists of two independent rotating members, a driving element and a driven element. The two members are separated by a space which is filled with small ferro-magnetic particles (stainless steel). When one of these members is energized, usually with an electromagnet coil, the particles polarize and bind together, this, in turn, binds the two rotating members together with a force that is in direct proportion to the energy induced.

The Clark Dynamatic Drive claims many advantages over conventional clutches and brakes such as: smooth engagement with

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no grab or chatter, continuous operation with negligible wear, instantaneous response, absorption of torsionals and peak vibrations, and operation as a clutch or brake in combination in either direction.

Information about specific applications can be obtained from The Clark Mfg. Co., 1830 East 38th St., Cleveland, 14, Ohio.

## BUSINESS NOTES

### Iron Fireman Changes Division Names

The Heating Control Div. of Iron Fireman Mfg. Co. will now be designated the Electronics Div., Frank S. Hecox, company vice president and treasurer, announced here.

The division will continue to manufacture electrical controls and other items of Iron Fireman equipment, Hecox stated. The new name was selected to eliminate local confusion with other Iron Fireman operations and to reflect an expansion into components for electronics systems and other types of electrical instruments.

### Milwaukee Office Opened by Ehret & Kinsey

Ehret and Kinsey, Chicago, who represent the Cleveland Worm & Gear Co., manufacturers of Cleveland Worm Gear Speed Reducers, and The Farval Corp., manufacturers of Centralized Lubricating Systems, announce the opening of a Milwaukee office at 2400 West Glybourn, Milwaukee 3, Wis., telephone Division 2-7844. Ehret and Kinsey have been representing these two companies in this area for twenty-six years. The Milwaukee office will be in charge of James A. Gramling.

### Air Products Laboratory

Another step in its long-range building program has been taken by Air Products, Inc., with the breaking of ground for the first unit of a research laboratory. Site of the new building is on a 31-acre tract in the extreme southeastern part of Allentown, Pa. Construction will begin immediately.

The ground-breaking ceremony followed the March meeting of the company's board of directors. With the directors and several company officers forming the audience, ground was jointly broken by Leonard P. Pool, Air Products president, and Anthony D'Argenio, president of CIO Local 143, United Electrical, Radio, and Machine Workers of America. Mr. D'Argenio is employed in the company's Emmaus plant. Both men "shared" a shovel and cooperatively turned the first earth.

The unit is the first of six which will eventually comprise the entire Air Products research department. It will be one story in height, of brick and block construction, and will house a library, office space, and laboratory. Dr. Otto J. Stern was recently named Air Products Director of Research.

The company manufactures oxygen-nitrogen generators and equipment employing extremely low temperatures used in the chemical and petroleum industries.

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### Pressure Vessel Codes

An article outlining the major differences between the ASME and the API-ASME Codes for unfired pressure vessels, "An Over-All Comparison Between Two Pressure Vessel Codes," by Walter Samans, member of the ASME Boiler Code Committee and past chairman of the Joint API-ASME Committee, is featured in the spring, 1953, issue of the *Alco Products Review*. Both general and specific differences are explained by Mr. Samans.

Other articles in the issue are "Engineering Development of Alco's New High-Pressure Closure," by Harold M. Alt; "Choosing the Right Material for Your Heat Exchanger," by T. N. Sieder and G. H. Elliott; and "Around the Petroleum World with Alco." Copies are available from the Public Relations Dept., American Locomotive Co., Schenectady 5, N. Y.

### Du Mont Opens Plant

Allen B. Du Mont Laboratories, Inc., television and electronics organization, has opened a new plant for the manufacture of cathode-ray instruments for industrial and defense use, Stanley F. Patten, vice-president, has announced.

The Instrument Div. plant is located at 760 Bloomfield Ave., in the Allwood section of Clifton, N. J., Patten said. It adjoins Du Mont's cathode-ray tube manufacturing plant and the company's main offices at 750 Bloomfield Ave.

The move, Patten pointed out, makes possible greatly increased expansion for the Instrument Div. and permit closer liaison between the division and the company's executive offices.

In the new plant, the Division has 75,750 sq ft of production and office space equipped for production and development of cathode-ray instruments. The plant has a total area of 118,000 sq ft. The remaining 43,000 sq ft will allow for future Instrument Div. expansion. Meanwhile it is used as a storage and shipping area by several of the company's divisions.

## LATEST CATALOGS

### Pressure Regulators

The Swartwout Co., designers and manufacturers of power plant, process control, and industrial ventilating equipment, has announced a 12-page bulletin on the company's line of pressure-regulating valves and pressure master controls.

Printed in two colors and punched to fit three-ring binders, the catalog is illustrated with photographs, cutaway and sectional views, and dimensional and specification data. It describes Swartwout Diaphragm-Operated Spring-Opening and Spring-closing Regulating Valves, Pressure Controllers, Air Locks, Valve Positioneers, and Selector Panels. The bulletin also lists Swartwout representatives throughout the United States, Canada, and Mexico. Copies of Bulletin S-22-CA are available on request to The Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

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### Solenoids

The National Acme Co. has published a catalog of its Namco "Stellite"-Welded Solenoids, with specifications for standard models, applications, ordering instructions for both standard and special solenoids, engineering data, and an accessories and parts list.

The catalog, Bulletin EM-52, is designed with heavy covers and an index tab for inclusion in $8^1/_2 \times 11$-in. files. Copies are available from the National Acme Co., Electrical Mfg. Div., 170 E. 131st St., Cleveland 8, Ohio.

### Thermistors

The Carboloy Dept. of General Electric Co. has published a detailed catalog of Carboloy Thermistors, available on request from the department at Detroit, Mich.

Information is classified under the following sections: General Information Section, which defines a thermistor, gives its basic, operating, and physical characteristics, and lists typical uses; Specific Data Section, containing temperature-resistance ratio characteristics; Carboloy Specification Section, with specifications for disk-type thermistors, washer-type thermistors, and rod-type thermistors; and Applications Section, suggesting applications in various industries.

### Roller Chains and Sprockets

A new bulletin on Baldwin-Rex Roller Chains and Sprockets has been published by Baldwin-Duckworth Div. of Chain Belt Co. The 54-page book describes the advantages of roller chain, and illustrates all the popular sizes of Baldwin-Rex Roller Chains. A section of the bulletin is a treatise on selection of standard roller chain drives, with formulas, tables, and examples. Roller chain dimensions, strengths, weights, and prices are included.

A section of the bulletin deals with stock sprockets, their characteristics and prices. Bore, keyway, and setscrew information is presented. Proper maintenance of chain drives is reviewed, and information on chain vises, flexible couplings, and coupling covers is provided.

The bulletin is available by requesting Bulletin #52-1 from Baldwin-Duckworth, Div. of Chain Belt Co., Dept. P. R., Springfield 2, Mass.

### Electric Heaters

A new Wing Electric Heater Bulletin describes the Wing line of electric unit-heaters and heater sections for general, industrial, and commercial heating as well as for specialized use in heating corners of factories, warehouses, guard houses, etc., as manufactured by L. J. Wing Mfg. Co., Linden, N. J.

The bulletin illustrates the three types of Wing electric heaters: the overhead, downward-discharge unit heater with revolving discharge outlets; the overhead, downward-discharge unit heater with stationary discharge outlets; and the utility unit heater, with horizontal discharge and adjustable vanes. In addition, the Wing electric duct heater section for oven-work, drying operations, and similar process heating is covered.

Engineering data includes capacity tables as well as dimensional data with mounting heights and coverage. The bulletin is identified as No. E-1.

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### Aircraft-Control Bearings

The Shafer Bearing Corp. has published a catalog devoted to the Shafer line of aircraft roller bearings, available in standard self-contained, single-row, double-row, rod-end, and special types for all conventional control applications for airborne craft.

The catalog contains specifications, engineering and application data, and relative merits of the basic Shafer ConCaVex design, which employs concave rollers and convex races. It is available from the Shafer Bearing Corp., 801 Burlington Ave., Downers Grove, Ill.

### Thermal Switches

Three leaflets are offered by Control Products, Inc., 306 Sussex St., Harrison, N. J., one on each of two thermal switches and one on an aircraft-type fire detector. Type ASA-21 Thermal Switch has a temperature range of 60 to 1500 F and is designed for jet engines, gas turbines, rocket motors, etc. Type ASA-13 Thermal Switch has a range of −40 to 800 F, is light in weight, and is intended for service in aircraft heaters, heat exchangers, de-icing systems, etc. Type BSA-4 Fire Detector has the advantages of fast action and light weight, and conforms to CAA, SAE, and U. S. Navy regulations.

### Pressure-Seal and Instrument Valves

A 16-page catalog describing pressure-seal stop, check, and non-return valves has been made available by Edwards Valves, Inc., East Chicago, Ind. Separate sections in the booklet give descriptions, design characteristics, and dimensional details of the valves. Each type is furnished in sizes from $2^1/_2$ in. to 14 in., and in 600-, 900-, 1500-, and 2500-lb pressure classes. Tables and charts are provided to aid in selection, together with chemical analyses and physical characteristics of materials.

Bulletin No. 491 gives information on the drop-forged steel Edwards instrument valves for meter, gage, instrument, and other small lines. These valves have a rating of 6000 lb WOG at 100 F or 1500 lb at 1000 F. Dimensions, weights, prices, and operating data are in the bulletin.

### Cooling Towers

The Water Cooling Div. of the Binks Mfg. Co. announces publication of a 4-page Bulletin 47-B describing the company's recently introduced line of Type 3-B Series Mechanical Draft Cooling Towers. The Type 3-B Towers are of spray-deck construction and use squirrel-cage blowers to create mechanical forced draft.

Bulletin 47-B contains complete performance data and specifications on the three following series of cooling towers: Type 3-B, Single Blower—capacity range, 1 to 36 tons of refrigeration; Type 3-B, Twin Blowers—38 to 72 tons; Type 3-B, Triple Blowers—88 to 108 tons. The manufacturer states that Type 3-B Cooling Towers are recommended for all installations in their capacity range where quiet and high cooling efficiency operation are important.

Copies of Bulletin 47-B will be mailed upon request to Binks Mfg. Co., Water Cooling Div., 3122 Carroll Ave., Chicago 12, Ill.

### Investment Casting Movie

A folder gives complete information on how to obtain the new color motion picture film entitled "Microcast, A Story of Industrial Progress." The film explains the development and uses of the Microcast process of precision investment casting and is available without charge. For folder, write Microcast Div., Austenal Laboratories, Inc., 7001 South Chicago Ave., Chicago 37, Ill.

### Metal Bellows

The Flexonics Corp. has published Catalog CMH-113, illustrating and describing Flexon stainless-steel and brass bellows, bellows assemblies, and bellows devices, and discusses the manufacture, design, specifications, dimensional standards, and application.

Sections on design considerations and specifications are in the catalog, available on request from Flexonics Corp., Maywood, Ill.

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**Stainless Steels**

"Armco Stainless Steels" is a concise catalog of stainless steels in all forms except tubing, and covers the company's technical services, fundamentals of stainless steels, various types of stainless steels and their physical and mechanical properties, fabrication, the blackening process, and electropolishing.

The catalog also contains brief descriptions of other Armco special-purpose steels and is complete with tables, charts, and illustrations. Copies will be sent on application to the Armco Steel Corp., 152 Curtis St., Middletown, Ohio.

**Pumps and Compressors**

Pennsylvania Pump & Compressor Co., Easton, Pa., has announced the publication of a comprehensive 6-page catalog which describes its line of air and gas compressors, Oilfreair and Oilfregas compressors, dry vacuum pumps, aftercoolers, Airchek valves, and centrifugal pumps for boiler feeding, general power plant, and industrial applications.

The catalog, Bulletin 546, is printed in three colors and contains pictures of each member of the Pennsylvania line together with a brief description, capacities, and sizes. It will be sent upon request.

**Alloy Metal Wires**

The Alloy Metal Wire Co., Prospect Park, Pa., has published a folder describing the steps in the manufacture of alloy metal wire. Included in the folder are a series of photographs depicting uses of alloy metal wires of various compositions. Among these are such products as welding rods, wire for automatic welding equipment, electronics equipment, woven wire cloth, spring and various consumer applications in jewelry, kitchen equipment, etc. Copies are available without charge from the Alloy Metal Wire Co., Inc., Prospect Park, Pa.

**Corrosion-Resistant Fastenings**

Described and illustrated in a new pamphlet are the major fastenings manufactured by the H. M. Harper Co. Available metals and sizes of bolts, nuts, screws, washers, rivets, and specials are included.

The pocket-size accordion-type folder provides a quick reference for those interested in solving fastening problems with nonferrous or stainless steel metals. Free copies may be obtained by writing The H. M. Harper Co., 8251 Lehigh Ave., Morton Grove, Ill.

**Chain Drives and Sprockets**

The Morse Chain Co., Detroit 10, Mich., has released three catalogs on its chain drives and sprockets. Catalog C 55-50 contains dimensional and pricing information describing Morse Stock Roller-Chain Sprockets in over 400 sizes, types A, B, and C, in addition to drive-selection data, service factors, and installation. Pertinent data on stock ASA roller chain, 3/8-in. to 2-in. pitch, is included.

Catalog C 71-48 offers data on the Morse Silent Chain Drive. Features of the catalog are its explanations of the exclusive "rocker joint" and assembly and disassembly, service factors, stock sprocket data, drive design and selection, installation, and maintenance.

Catalog C 72-51 describes a new high-speed, heavy-duty mechanical power-transmission chain drive, the Morse Hy-Vo Drive. Operating principles of all chain drives and the new design principles of Hy-Vo drives, and capacities, speed ranges, and service factors of the Hy-Vo drive are discussed.

All booklets are available from the Morse Chain Co., Detroit 10, Mich.

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### Flexible Metal Hose

Titeflex, Inc., 500 Freylinghuesen Ave., Newark, N. J., offers a bulletin on its Titeflex hose, a convoluted metal tube designed so that flexing which takes place is within the natural limits of the metal. Titeflex hose will withstand pressure, temperature, vacuum, vibration, and corrosion by various liquids and gases.

### Electrical Machinery

"Catechism of Electrical Machinery" is the title of Bulletin E100H, available from Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill. The bulletin describes the most important theoretical and practical features of common types of direct-current and alternating-current motors, generators, and control equipment.

The bulletin is designed for those not familiar with electrical phenomena or terminology. Photographs of Fairbanks-Morse machinery illustrate the text.

### Locknuts and Collars

Two 4-page bulletins, one on Flexloc self-locking nuts and the other on Hallowell steel shaft collars, have been prepared by Standard Pressed Steel Co., Box No. 558, Jenkintown, Pa. Both give information in text and illustrations on product properties and applications.

Flexloc locknuts are one piece and all metal, do not have to seat to lock, and can be used as stop nuts because they will stay put at any point on a belt or stud. The sizes and the metals are listed in which locknuts (thin and regular) are available. Sizes of Flexloc external wrenching nuts and clinch nuts are also included.

The bulletin on Hallowell steel collars lists the 42 standard sizes for shafts from $^3/_{16}$ in. to 3 in. in diameter. The collars are fitted with Unbrako knurled cup-point, self-locking socket set screws. The bulletin shows the Hallowell collar in use on textile machinery, movie projectors, printing equipment, lift trucks, and other industrial machinery.

### Hydraulic Duplicators

A bulletin describing its hydraulic duplicating follower for machine tools has been published by the Turchan Follower Machine Co., 8259 Livernois Ave., Detroit 4, Mich. The follower enables a pattern or template to be duplicated in metal by a milling machine, lathe, shaper, or grinder. Advantages listed by the manufacturer are: faster production, adaptability to any size or type of machine, ability to duplicate any desired shape, elimination of skilled machinists, reduction of hand finishing operations, and expansion of shop capacity.

Photographs of the Turchan Follower in operation on several different machines are included in the bulletin, together with a variation, the Turchan 45-Deg Lathe Compound Attachment, used to duplicate work on lathes. The operation of the follower is explained, utilizing a circuit diagram of the attachment. The bulletin is available on request from the company.

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### Roller Chain

Book No. 2457, published by the Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill., discusses precision steel roller chain and its application. Detailed engineering information covers selection, installation, lubrication, and maintenance of roller chain and sprocket wheels for drives and conveyors. Copies are available on request.

### Bin Flow Aerator

The Bin-Dicator Co., 134946 Kercheval St., Detroit 15, Mich., has published a bulletin giving description and illustrations of its Bin-Flo Aerator unit, with application data, typical layouts, air pressure consumption supply and piping data, specifications, prices, installation instructions, and a list of present users. The device provides a flow of any dry powdered ground material from bins, hoppers, and chutes by introducing small volumes of low-pressure air.

### Motor Controls

Cutler-Hammer's new line of A-C Magnetic Starters for electric motors is described in the latest issues of bulletins for Cutler-Hammer "Custom-Built" Catalogs. Advantages claimed for the starters are 180-deg accessibility, clearly marked terminals with pressure connectors which grip wires of any size, ample wiring room, key-slotted, embossed mounting holes, wire-retaining channel for convenient placing of wires, vertical dust-safe contacts, life-time pivoted bearing which eliminates sliding friction and wear, lifetime rust-resistant enclosure, and light-weight, movable contacts to reduce bounce and resultant arcing.

Other features are color-coded wiring, rigid unit panel, and vacuum-impregnated magnetic coil. Dimensions and specifications for different NEMA sizes are given, including wiring diagrams. Cutler-Hammer "Custom-Built" Catalogs include bulletins on those Cutler-Hammer products of most interest to the individual customer, to whom latest revisions are sent as issued. Any additional bulletins desired are sent if requested. This procedure eliminates the necessity of filing bulletins of no interest.

Further information is available from Cutler-Hammer, Inc., Milwaukee 1, Wis.

### Dual-Fuel Engines

Publication of a three-color, 16-page bulletin on the design, construction, operation, and application of Nordberg two-cycle Duafuel engines is announced by Nordberg Mfg. Co., Milwaukee 1, Wis. The Nordberg Duafuel engines described in Bulletin 202 are built with either high- or low-pressure fuel-injection systems to meet specific operating conditions. These engines, built in 29-in., $21^1/_2$-in., and $17^1/_2$-in. cylinder-bore sizes, are designed to burn gas plus pilot oil, fuel oil only, or intermediate proportions of either fuel.

Design features of Nordberg Duafuel operation are discussed in this bulletin, including descriptive data on the pilot oil injection system, hydraulically actuated gas valves, forced-feed lubrication, and positive-action safety devices. Bulletin 202 is also illustrated with typical engine installation views and many of the operating advantages are listed. Bulletin 202 is available free upon request.

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### Low-Pressure Pipe Line Filters

A new 4-page illustrated bulletin describing four new low-pressure pipeline filter models has been announced by the Dollinger Corp., Rochester, N. Y. The bulletin contains specifications and engineering and performance data covering the new filter, which the manufacturer recommends for the removal of dust, dirt, pipe scale, and condensed oil and water vapor from compressed air lines. One-bolt construction permits media cleaning without breaking pipeline connections. A copy of Bulletin No. 210 is available from the Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.

### Drip-Proof Induction Motors

The Lima Electric Motor Co. has just completed a new brochure presenting the complete line of Lima Drip-Proof Induction Motors. The brochure includes speed-torque curves, frame number charts, dimensions and specifications for Lima motors from $^1/_2$ to 150 hp, as well as descriptions of variations for optional mounting and special purpose applications. The new bulletin also covers recent changes in design, including use of prelubricated sealed ball bearings throughout. For copies write to Mr. Richard R. Knierim, Sales Mgr., The Lima Electric Motor Co., Dept 75, Lima, Ohio.

### Flexible Couplings and Friction Clutches

Catalog SDOC describes the Morse Chain Co. line of small-diameter, over-center friction clutches. Drawings of applications and tables of specifications and installation dimensions complete the catalog.

Catalog C 41-48 covers Morse Morflex Flexible Couplings and their construction and selection. Torsional deflection, dimensions, capacities, and typical and special applications are discussed.

Both catalogs are available from the Morse Chain Co., 7601 Central Ave., Detroit 8, Mich.

### Tool Steel

The Latrobe Steel Co. has issued a bulletin on its Electrite Double-Six M-2 "Desegatized" High-Speed Steel. A typical analysis is given, and recommended instructions for forging, hardening, preheating, annealing, quenching, tempering, machining, and grinding are included.

Impact and hardness test results are tabulated. Recommended uses for the steel are in blanking punches, blanking dies, boring tools, broaches, counter bores, gear cutters, hobs, lathe tools, milling cutters, planer tools, taps and dies, twist drills, and similar tools. Copies are available on request.

### Tube Mills

Hardinge Co., Inc., York, Pa., has issued a new 12-page catalog, Bulletin No. 18-B, describing its line of tube mills for grinding and pulverizing. The catalog discusses the application, construction, and specifications for the Hardinge pebble tube mill and the Hardinge ball tube mill. It also illustrates several types of compartment mills. The primary application of the tube mill is found in processes where a finished product with high superfine content is desired or where two or more materials must be thoroughly ground together. It may also be used with classifying equipment.

### Surface Durability of Gears

"Evaluating Surface Durability of Gears", 5 pages, illustrations, and charts, describes an improved technique aimed to test gears under controlled conditions of load, temperature, speed, and lubrication, eliminating other variables. Test results in deterioration by pitting rather than by tooth breakage. A noise meter is used to determine the point at which failure begins. Test machine, specimen and procedure are described. Typical test data demonstrates the results obtainable. The booklet is available from International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.

KEEP INFORMED — NEW EQUIPMENT — BUSINESS NOTES — LATEST CATALOGS

### Stainless Steel Wire

A 20-page booklet of technical data on the application of stainless steel wire has recently been published by Allegheny Ludlum Steel Corp.

Nearly all grades of Allegheny Metal are now available in wire form, the company announced.

Tables of physical properties, corrosion resistance, and analysis are included to help the reader in considering the various types. A discussion of the principal uses of stainless wire covers cold heading, weaving, heat-resisting belts, rope, spring wire, slide forming, welding, and winding. Copies of the booklet are available on request from the trade by writing to Allegheny Ludlum Steel Corp., Advertising Dept., 2020 Oliver Bldg., Pittsburgh 22, Pa.

### Space Heaters

Bulletin No. 543, just released by Dravo Corp., Heating Dept., Pittsburgh, Pa., illustrates a new line of suspended space heaters for use with any type of gas fuel. This new gas-fired heater has been added to the line of Dravo Counterflo Heaters.

The 6-page folder gives complete specification data with dimensions and capacities of both propeller-fan- and blower-type units. Available output capacities of these gas-fired suspended heaters range from 70,000 to 178,000 Btu per hr. Full explanations show how they can be used in commercial and industrial applications for heating, ventilating, and process drying, either with or without ductwork. The heaters have cast-iron burners and heat exchangers and are approved by the American Gas Assn. and are listed by the Underwriters' Laboratories, Inc.

### Railroad Radio Booklet

Heavy-duty railroad radio equipment (Type FE) is described in an 8-page booklet available from the Westinghouse Electric Corp. The booklet describes features of the equipment that enable it to readily fulfill five needs of railroad radio communication: (1) end to end; (2) train to train; (3) wayside to train; (4) dispatcher to any wayside or train; (5) bridging wire-line breaks in an emergency.

The electrical and mechanical description of the equipment includes ratings, dimensions and weights, and power requirements. For a copy of this booklet, B-5787-A, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

### Batch Hardening Furnaces

Gas-fired, batch-type hardening furnaces are featured in a new illustrated bulletin just released by Surface Combustion Corp., Toledo, Ohio. Direct-fired, horizontal-hearth, types and circular and rectangular salt-pot types are included. Also shown is a complete line of controlled atmosphere equipment for hardening. This includes individual prepared atmosphere generators, horizontal and vertical muffle furnaces, and the new "All-case" high production furnace incorporating radiant tubes, recirculating fan and a totally enclosed oil quench. Copies of Bulletin SC-161 are available direct from Advertising Dept., Surface Combustion Corp. Toledo 1, Ohio.

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### Oil Burners

Catalog AD-102 covers the complete line of Cleaver-Brooks Hev-E-Oil Burners for commercial, industrial, and institutional installations. The catalog contains illustrations of various models; listings of features, applications, and specifications; and illustrations of the major feature advantages.

Units are offered in six sizes, burning from 1 to 60 gal. per hr, and a table of specifications of each size is given. The catalog is available from the Cleaver-Brooks Co., Hev-E-Oil Burner Div., 326 E. Keefe Ave., Milwaukee 12, Wis.

### Flexible Metal Hose

A new two-color bulletin on CMH Flexible Metal Hose has just been released by Flexonics Corp., Maywood, Ill.

The bulletin emphasizes the range of hose types and assemblies available from this manufacturer. One section pictures some of the more common flexible hose installations, while another includes an application chart, showing the type of CMH assembly to use for handling various kinds of liquids, gases, solids, and semi-solids.

For a copy write Flexonics Corp., 1305 South Third Ave., Maywood, Ill., designating bulletin CMH-122R.

### Packaged Ventilating Equipment

The Clarage Fan Co., Kalamazoo, Mich., has issued a catalog illustrating its standard packaged fan and ventilating units. Tables of specifications for the different sizes and styles of ready units are included.

The fans are V-belt driven and are intended for handling 100 to 12,000 cfm at low static pressures. The featured advantages of the Clarage units are discussed, and a section on selection is added. Copies are available by requesting Catalog 515 from the company.

### Starter Selection Guide

Tips on selecting the right starter for squirrel-cage induction motors rated up to 600 hp at 600 v or less are contained in a new bulletin released by Allis-Chalmers Mfg. Co. Information included in the bulletin tells how to select the proper type starter, enclosure, and operating arrangement, and explains how to determine whether a full- or reduced-voltage starter should be used.

An explanation of two or three-wire control and hints on the selection of heater elements for overload relays are also given in the bulletin along with a cage motor starter selection chart. Copies of this Allis-Chalmers selection guide for general purpose starters, 14B7733, are available upon request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

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### Mechanical Packings

Albert Trostel Packings, Ltd., Lake Geneva, Wis., has published a catalog of its leather and synthetic rubber packings for hydraulic and pneumatic applications. Recommended uses and suggestions for installations are given, with cutaway drawings, for leather and synthetic rubber cup packings, V-packings, U-packings, flange packings, back-up washers, and O-rings for hydraulic use; and cup packings, V-packings, U-packings, flange packings, back-up washers, and O-rings for pneumatic use.

Standard sizes for all the various packings, washers, and O-rings are included, together with ordering instructions. The design, development, and production facilities of the company are described and illustrated.

### Synthetic Rubber Parts

"Molded Mechanical Parts of Synthetic Rubber" describes the manufacture and suggested uses of parts made from synthetic rubber by the Allis Rubber Corp., 113–125 North Green St., Chicago 7, Ill.

Different kinds of synthetic rubbers are described, with their principal characteristics. Allis compounding, extruding, molding, inspection, trimming, and laboratory operations are illustrated and discussed. Diaphragms, boots, bellows, gaskets, valve parts and cups, U-packings, and some special shapes are pictured. A table of the properties of five synthetics compared to those of natural rubber is included in the booklet, available on request.

### Solenoid Valves

Bulletin 3C-1 gives full details and operating characteristics of the new Barksdale line of Crescent three-way solenoid-operated pilot-controlled valves. The valves come in sizes from 1/4 to 3/4 in. iron pipe size, and handle pressures up to 500 psi of air, water, or light oil. They have free port areas equal to or greater than the internal cross-sectional area of the corresponding pipe, the manufacturer states. Crescent solenoid-operated pilot-controlled four-way valves for air, water, or light-oil pressures to 150 psi are also described in the bulletin.

Dimensional data, ordering information, and other specifications are included in the bulletin, which is available on request from Barksdale Valves, 1566 E. Slauson Ave., Los Angeles 11, Cal.

### Injection Molding

Sarco Technical Bulletin No. 7, "Faster Injection Molding Cycles thru Mold Temperature Control?," compiles the comments of experts on ten questions concerning temperature control of molds in injection molding. The comments are from technical bulletins, letters, the *Modern Plastics Encyclopedia*, and other sources.

A chart of the effects on various molding compounds of a too-low mold temperature and a too-high mold temperature is given, as well as questions and answers that bring out the features of Sarco's Sarcotrol mold heating and cooling unit, Model JS-1, for injection molding machines. The Sarcotrol Model JS-1 is photographed and diagrammed. Copies are available from the Sarco Co., Inc., Empire State Bldg., New York 1, N. Y.

# KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

### Oil Burners

The Engineer Co. has released Bulletins OB-PC and OB-37, describing its range of mechanical or steam-atomizing type of oil atomizers for all styles of pulverized coal burners, gas- or oil-burning registers, and fuel-oil pumping and heating systems.

### Fastener Problem Solutions

Details of how a wide variety of design problems were solved with self-locking fasteners are contained in a new 32-page booklet available from Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N.J.

Examples of how weight savings, reductions in assembly time, simplified design, maximum joint security, and similar benefits were obtained are described and illustrated in case-history form.

### Oscillating Conveyors

Link-Belt Book No. 2444 contains layout drawings, selection charts, dimensions, and weights for "PA" positive-action eccentric-type oscillating feeders and conveyors. Both torsion-mount styles for heavy duty and Flexmount for light duty are covered. Oscillating conveyors are recommended by the manufacturer for materials that are sharp, abrasive, fine, lumpy, sticky, or hot. Copies are available from the Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

### Integral-Seat Valves

Edwards Valves, Inc., East Chicago, Ind., has published an 8-page catalog of its Univalve integral-seat, all-purpose, forged-steel valves, rated for 1500 to 2500 lb. Specifications for materials, including chemical analyses and physical characteristics, are given.

Univalve features, such as impactor handwheel, streamlined straight-through flow passages, positive backseat, and leakproof bonnet are illustrated. A special picture section shows step-by-step the disassembly procedure.

### Maintenance of Clad Steel Equipment

An illustrated guidebook, "Cleaning and Maintenance of Clad Steel Equipment," has been published by Lukens Steel Co., Coatesville, Pa. Pointing out the small amount of maintenance and low-cost cleaning necessary for stainless and nickel alloy equipment, the guidebook outlines for maintenance personnel recommended cleaning procedures for those types of surface contamination which are potentially harmful. It contains solution formulas for cleaning specific kinds of surfaces, and includes information on handling clad steel equipment during relocations.

Users of clad steel equipment may obtain copies of this guidebook from fabricators who supply equipment of these materials.

### Air Conditioners

Information on Trane self-contained air conditioners is published in Bulletin D-362, offered by the Trane Co., LaCrosse, Wis. Mechanical data, unit selection information, refrigeration capacities, condenser-water requirements, water-valve data, fan performance, electrical characteristics, etc., are in the bulletin.

### Variable-Speed Drive

A concise description of Morse Variable Speed Units and a complete listing of all parts and disassembly, inspection, servicing, and operating principles are contained in a 12-page manual, "Service Manual for Morse Variable Speed Drives." The manual is available from the Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

### Disc-Type Electric Motors

Bulletin DT-1, describing the Howell line of disc-type electric motors, is offered by the Howell Electric Motors Co., Howell, Mich. Several applications are described and illustrated. Use of the disc-type motors gives a reduction in length of 41.7 to 50.5 per cent, depending on horsepower, the manufacturer states.

Typical speed-torque curves of polyphase motors, showing characteristics that can be obtained from the disc-type motors, are given, and a table of dimensions is included.

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### Electric Heaters

A 1953 edition of General Electric's catalog on Calrod electric heaters and heating devices has been announced as available from the company, Schenectady 5, N. Y. Designated as GEC-1005D, the 60-page, two-color information and buying guide describes the equipments in terms of application, special features, installation, and pricing.

The catalog is indexed by process and application, and contains methods of determining power requirements and heat losses by applications. These are explained by both graphs and formulas. Another feature of the publication is an index of General Electric application bulletins, and data and specification sheets available.

A total of 175 photographs and drawings illustrate the various heater-types of products, including immersion, strip, cartridge, tubular, insertion, and fin heaters, and melting pots, thermostats, switches, oven heaters, and induction heaters.

### Motor-Generators

A motor and generator reference booklet to assist in the selection of motive power to handle most industrial applications is being made available by Allis-Chalmers Mfg. Co.

The 50-page pamphlet is reprinted from the 1952 edition of Lincoln's Industrial-Commercial Electrical Reference published by the Electrical Modernization Bureau, Inc., Text and illustrations on integral horsepower motors and generators for the book were furnished by Allis-Chalmers in cooperation with with the Electrical Modernization Bureau.

Copies of "Allis-Chalmers Motor and Generator Reference Book," 51R7933, are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

The complete 1768-page Lincoln's Industrial-Commercial Reference can be obtained for $18.75 delivered from the Electrical Modernization Bureau, Inc., 110 Mamaroneck Ave., White Plains, N. Y.

### Conveyor and Elevator Belts

A 32-page manual on the installation and maintenance of conveyor and elevator belting has just been published by The B. F. Goodrich Co., Akron, Ohio. More than 60 photographs and drawings illustrate ways to improve belt service and to lengthen belt life.

A chapter on how to select belts includes a discussion of belt design, covers, reinforcements, and grades. There is a detailed review of the engineering information required to specify a new conveyor belt. Belt repair methods and belt splicing and fastening are covered in detail.

The recently announced B. F. Goodrich Turnover conveyor-belt system for handling wet, corrosive, sticky, or freezing material is described in full. Developed especially for this manual is a table which lists common conveyor belt maintenance problems, the cause of each one, and the recommended remedy for the situation.

Other topics covered in detail include ways to make conveyor belts run straight, the causes and effects of excessive tension, the selection and installation of pulley lagging, ways to avoid belt wear at loading point, use of damage-preventing appliances, types of compensating idlers, and the effects of defective idlers.

# KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

### LP-Gas Storage Tanks

Scaife Co., Oakmont (Pittsburgh district), Pa., has published a new bulletin describing its recently announced line of ASME tanks developed to meet the need for larger above-ground LP-gas storage facilities.

The bulletin emphasizes several new features incorporated in the design of the 285-gal. and 500-gal. LP-gas tanks, which are fabricated of lightweight high-strength steel and incorporate ellipsoidal heads for maximum durability. Copies of the bulletin, No. 331, will be sent by the Scaife Co., Oakmont, Pittsburgh district, Pa.

### Vertical Agitator Drive

Western Gear Works, 417 Ninth Ave. South, Seattle 4, Wash., has announced the availability of a new technical bulletin entitled "Pacific-Western Vertical Agitator Drives."

This bulletin covers a complete line of vertical agitator drive units for application on any type of food- or chemical-processing agitator tank. The driving motor is an integral part of the unit, which offers space-saving advantages over the usual right-angle drives. A free copy of this bulletin may be obtained from Western Gear Works, directing the inquiry to Mr. Paul Forsythe, Mgr. of Sales and Engineering.

### Preparation for Galvanizing

A 4-page folder, "Recommendations for the Proper Preparation of Materials Prior to Hot Dip Galvanizing," has been published by the American Hot Dip Galvanizers Assn., Inc., of Pittsburgh, Pa. The folder illustrates and discusses the proper design and fabrication of a wide variety of products prior to hot dip galvanizing.

The folder is available free to anyone interested from the Association offices, 1507 F First National Bank Bldg., Pittsburgh 22, Pa.

### Data Card on Tubing Steel

One of the alloy tubing steels widely used in elevated temperature service is discussed in a new technical data card issued by the Tubular Products Div. of The Babcock & Wilcox Co. Known as TDC-146, the bulletin discusses B&W Croloy 5 (4–6 per cent chromium, 1/2 per cent molybdenum).

This steel is used in refinery and other process-industry applications as furnace tubes, piping, and superheater tubing. It is particularly resistant to corrosion from hot oil, hydrogen sulfide, elementary sulfur, and organic sulfur compounds as encountered in petroleum processing. Included in the bulletin are data on mechanical properties, creep strength, physical properties, welding, fabrication, and heat treatment. Copies of bulletin TDC-146 are available, free, on request to the company's offices at Beaver Falls, Pa.

### Radiation Detectors

A 4-page Specification Sheet 84 describes and illustrates Radiamatic compensated radiation detectors. These units generate an emf proportional to the temperature of the object sighted on, and are designed for use with a wide variety of pyrometric instruments. General-purpose, small-target, miniature- and low-range Radiamatic units are covered. Construction and engineering details are included. Address inquiries to Minneapolis-Honeywell Regulator Co., Industrial Div., Station 64, Wayne and Windrim Aves., Philadelphia 44, Pa.

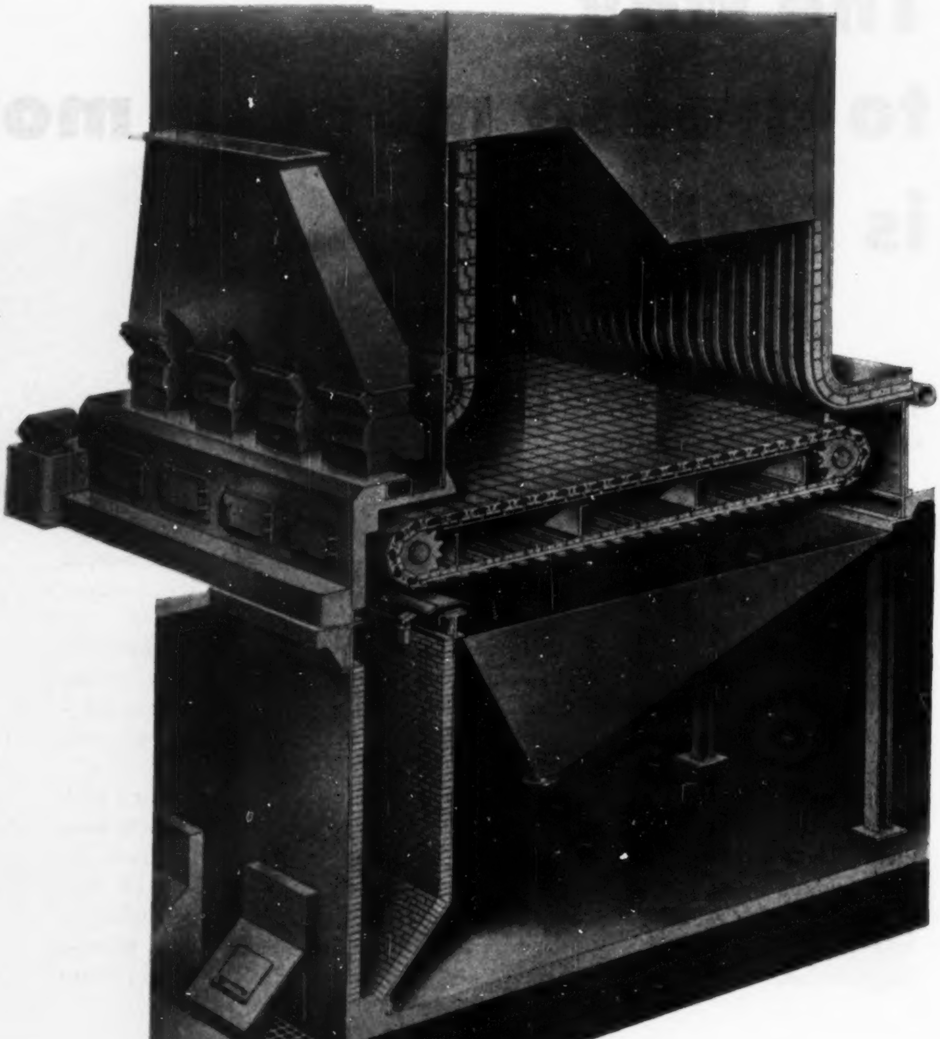
### Power Screw Drivers

Form 5056 describes Ingersoll-Rand's air-powered screw drivers. A cutaway view shows the clutch system of the screw drivers. Tables of specifications for each model bit, for both socket-head and slotted-head screws, and for sockets and socket-drivers for light nut and cap-screw running are included.

A bit-selection table and a screw-size table aid in the proper choice of bit. A series of examples of the money-saving advantages of Ingersoll-Rand air-powered screw drivers conclude the leaflet. Copies are available from Ingersoll-Rand, 11 Broadway, New York 4, N. Y.


WHAT *Life-Line* REALLY DELIVERS IS MORE SERVICE . . . LESS SERVICING

FIRST
Firite
SPREADER



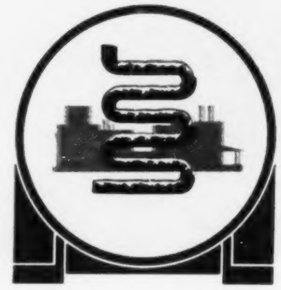
*Illustrating a Hoffman Continuous Ash Discharge Stoker*

**HOFFMAN COMBUSTION ENGINEERING COMPANY**

Pumping

Ventilating

Metal Forming



Refrigeration

Oil Well Pumping

# Electric Motors

## *for every industry*

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

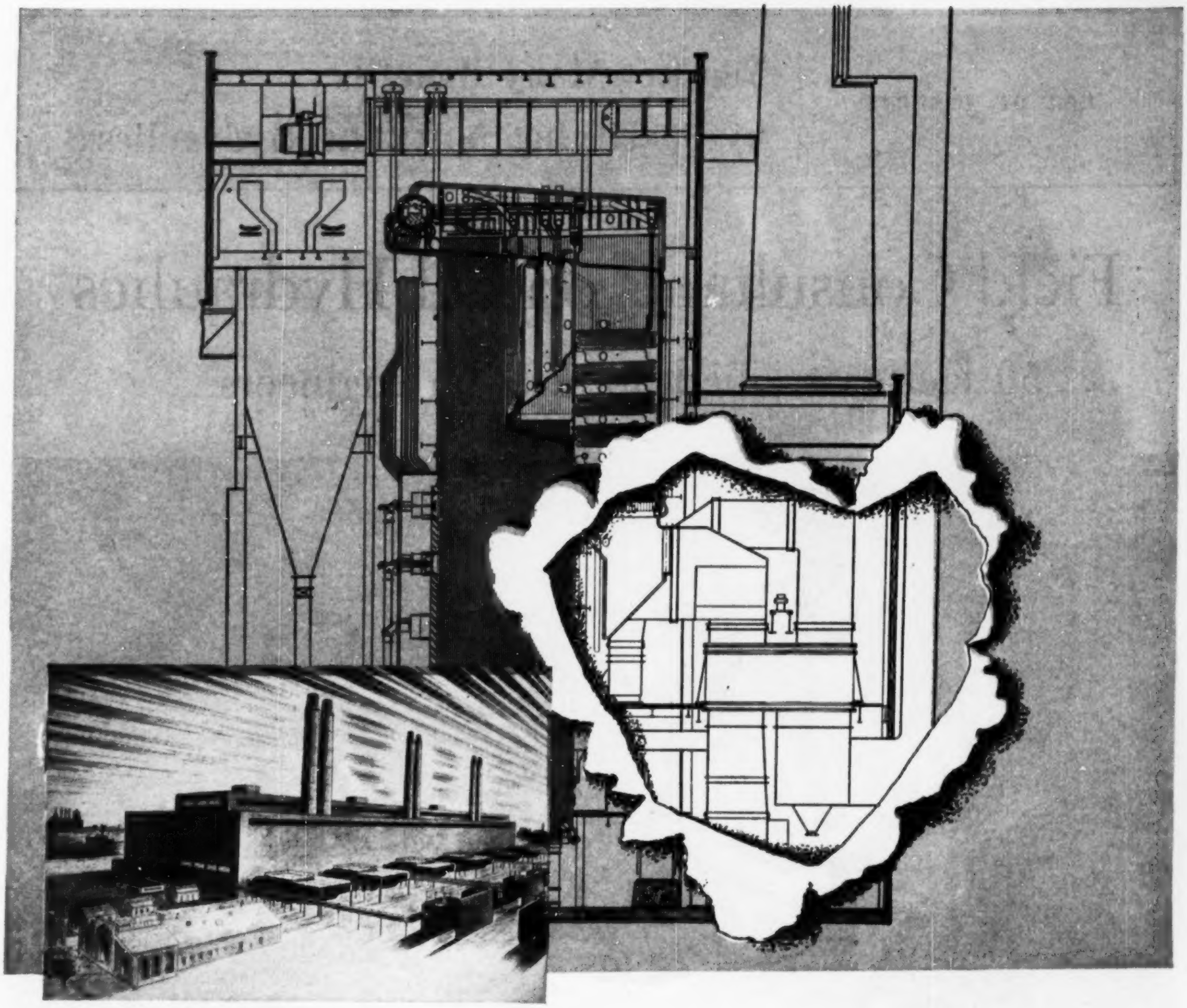
Fairbanks, Morse & Co., Chicago 5, Illinois.

**Fairbanks-Morse QZK Motors—in a complete horsepower range.**

**FAIRBANKS-MORSE**

***a name worth remembering when you want the best***

ELECTRIC MOTORS AND GENERATORS · DIESEL LOCOMOTIVES AND ENGINES · RAIL CARS · PUMPS · SCALES · HOME WATER SERVICE EQUIPMENT · FARM MACHINERY · MAGNETOS



**Reheat Boilers at Astoria Station of the Consolidated Edison Co. of New York, Inc.**

***equipped with***

# LJUNGSTROM AIR PREHEATERS

As part of its immense expansion program, Consolidated Edison Company of New York will place its new Astoria Station in service in the early spring of 1953. Ultimately to have a capacity of 1,000,000 kilowatts, the station's first unit will generate 180,000 kilowatts, with a duplicate unit to follow in a few months.

Astoria Station was designed by the staff of Consolidated Edison, and is being built by various contractors. Its 160,000-kw (nameplate rating) turbine-generators each will be powered by a Babcock & Wilcox reheat boiler, rated at a continuous capacity, coal fired, of 1,200,000 pounds of steam per hour at 1850 psi and 1000 F, reheated to 1000 F.

Each boiler at this huge new station will be serviced by two Ljungstrom Air Preheaters, which will preheat incoming air to approximately 560 F, and cool exit gases to 250 F.

Once again—as is the case with millions of kilowatts of generating capacity all over the country—the Ljungstrom Air Preheater was selected for high-performance steam generating equipment. The unanimity with which the Ljungstrom has been chosen—by utilities . . . by industry . . . by consultants . . . by boiler manufacturers—for efficient steam generating units can be your guide, too, to steam generation with top fuel economy.

**THE AIR PREHEATER CORPORATION, 60 East 42nd Street—New York 17, N. Y.**

ONE OF A SERIES

**You Get Many Benefits by Specifying VICKERS Hydraulics**

# Field Consultants on Oil Hydraulics

## ... 50 factory-trained application engineers

Vickers Application Engineers are a group of 50 specially trained and salaried men assigned to Vickers offices strategically located throughout the country. These men are selected for technical background and imagination. Each is given a very thorough training in Vickers plants before he goes to a field office. Training includes all phases of oil hydraulics, both theory and practice.

As a result, these men are uniquely qualified to help you in making hydraulics more useful to you and your customers. Their services take many forms . . . from complete circuit design to helping get the "bugs" out of a prototype machine.

They have at their command the wealth of Vickers Hydraulics resources. Contact the nearest Vickers Application Engineering Office whenever you have a problem where oil hydraulics may be helpful.

**VICKERS Incorporated**

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6358

**ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921**

Remember the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.


# *Engineered* for tough service

THIS TUBE-TURN Welding Neck Flange will contain greater pressures under temperature extremes, and will last longer than other types under repeated bending or vibrations of piping. It is *engineered* for tough service . . . with a long, tapered hub, and a smooth transition in thickness to the pipe-end bevel.

You can select the exact Welding Flanges you require from TUBE TURN's complete line: welding neck; slip-on; lap joint; socket welding; blind; orifice; or pipeline non-standard flanges. It *pays to specify* TUBE-TURN Welding Fittings and Flanges. Call your nearby TUBE TURNS' Distributor . . . you'll find one in every principal city.

Be sure you see the double "tt"

**TUBE TURNS, INC.** LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York · Philadelphia · Pittsburgh · Chicago · Houston · Tulsa · San Francisco · Los Angeles · Denver · Atlanta

Subsidiaries: TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO • PENNSYLVANIA FORGE CORPORATION, PHILADELPHIA, PA.

ENGINEERING SERVICE

# TUBE TURNS' *Engineering Service*
# HELPS DEVELOP NEW PIPING TECHNIQUE

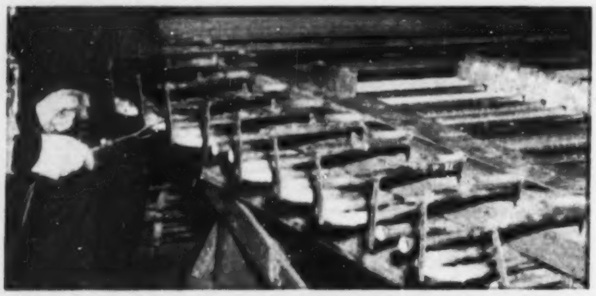
D. R. Cheyney, of TUBE TURNS' Engineering Service Division, has had wide experience in alloy and non-ferrous applications.

THIS STORY of how a large processor saved $50,000 and conserved scarce copper with a new approach to a piping application shows why TUBE TURNS, INC. is so highly regarded as an authority on piping engineering.

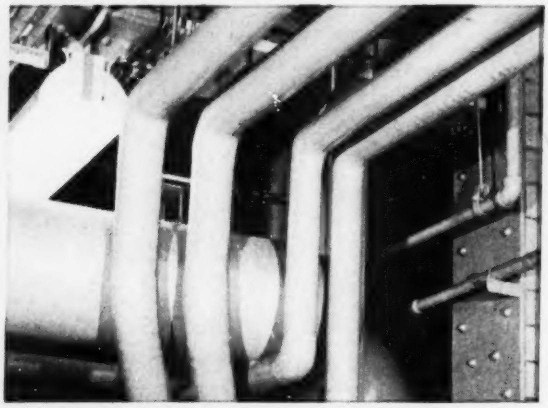
The problem involved the retubing of seven cooling units, formerly fabricated from copper tubing and fittings. Aluminum was considered as a replacement; however, there were no satisfactory methods for welding thin-walled aluminum tubing to welding fittings. TUBE TURNS' Engineering Service Division, working with Alcoa, came up with the solution. A new brazing technique was developed, and special TUBE-TURN Welding Returns, and TUBE-TURN Welding Elbows were supplied.

TUBE TURNS' Engineering Service is ready to help *you* in such special applications.

**SPEEDS FABRICATION**—TUBE-TURN Welding Fittings have won a reputation for dimensional accuracy that pays off in fast, easy alignment and fabrication. Time often is saved by welding assemblies in the shop, quickly tying them into the job.



TUBE-TURN aluminum long-radius Welding Returns being brazed to aluminum tubing, in fabrication of cooling coils.



**SPACE SAVER**—Welded piping makes a compact, neat installation—and requires no maintenance. Streamlined, its insulation is more easily applied.

**Want Dimension Data?**

TUBE TURNS, Inc. has compiled a handy folder of charts covering dimensions and weights of TUBE-TURN Welding Fittings and Flanges. If you'd like a free copy just send this coupon.


TUBE TURNS, INC., Dept. F-6
224 East Broadway, Louisville 1, Kentucky

*Your name* ..............................
*Position* ..............................
*Company* ..............................
*Nature of Business* ..............................
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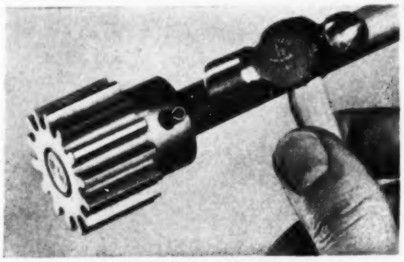
"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

# TUBE TURNS, INC.
LOUISVILLE 1, KENTUCKY

# Where can you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

**No threading, peening or precision drilling with** ROLLPIN



It compresses as driven.

Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

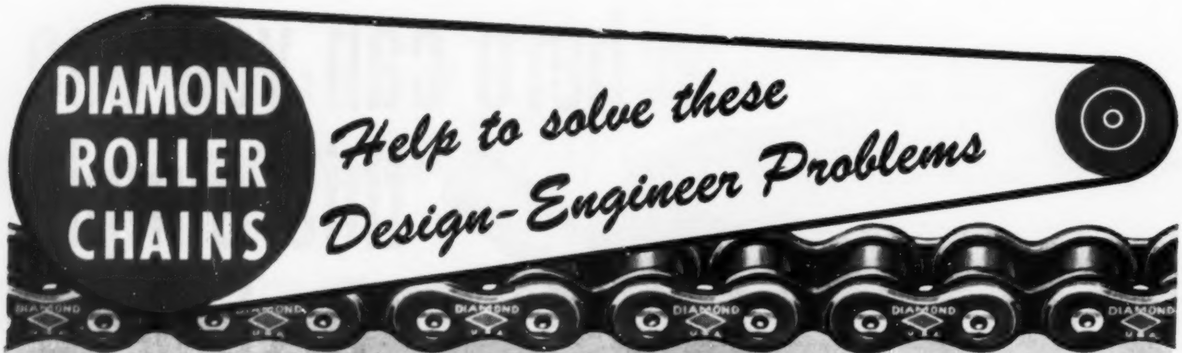
*If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.*

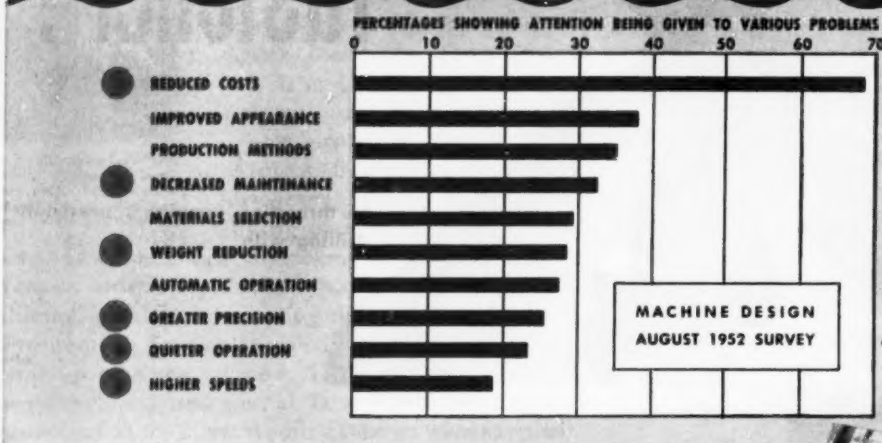

**Elastic Stop Nut Corporation of America**
**Dept. R16-611, 2330 Vauxhall Road, Union, N. J.**

**Please send me the following free fastening information:**

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

Name ______ Title ______
Firm ______
Street ______
City ______ Zone ______ State ______




**Shot-Peening Since 1944**

Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.

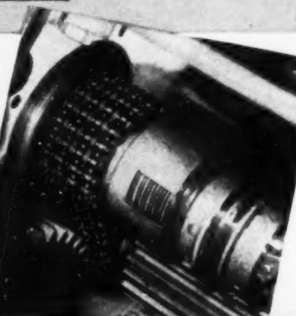
**Another Diamond Advantage**

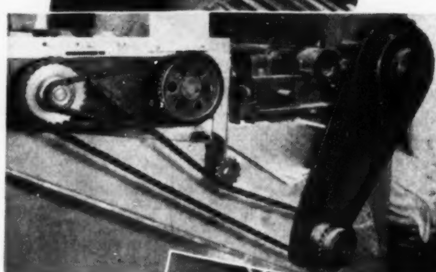
Fully equipped and well staffed chemical and physical testing laboratories have made it possible to control raw material specification, their treatment and processing.

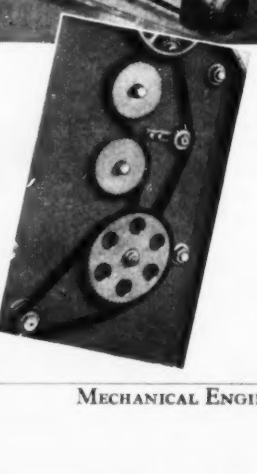
In the case of six of the problems designated by the *Machine Design* survey, Diamond Roller Chains provide definite help:

- **REDUCED COSTS**—Ease of installation and simplification of design reduce costs. Center distances can be short or long. And absence of separating forces reduce size and cost of bearings.
- **DECREASED MAINTENANCE**—Longer life; load is distributed over many teeth. Ease of adjustment or replacement minimizes maintenance.
- **WEIGHT REDUCTION**—Diamond Roller Chains are light compared to tensile strength and power transferred. Sprockets mesh with either side of chain eliminating heavy gear trains for multiple shaft operation.
- **GREATER PRECISION**—No slip or stretch, with definite speed ratio maintained. Diamond Chains are pre-loaded before shipment.
- **QUIETER OPERATION**—The precision manufacture of all parts, the free roll of bushings and rollers result in smooth, quiet operation at all speeds.
- **HIGHER SPEEDS**—Diamond Roller Chains are so light in relation to power transmission capacities and tensile strengths that, for all pitches and multiples, chain loading due to centrifugal force is entirely negligible at all normal ranges of chain speed, even to 4000 f.p.m.

Product design engineers will find the experienced Diamond engineering staff ready at all times to make practical recommendations. Our Catalog 709 is a helpful guide to have available for ready reference.







**DIAMOND CHAIN COMPANY, INC.**

***Where High Quality is Tradition***

**Dept. 413, 402 Kentucky Ave., Indianapolis 7, Indiana**

***Offices and Distributors in All Principal Cities***

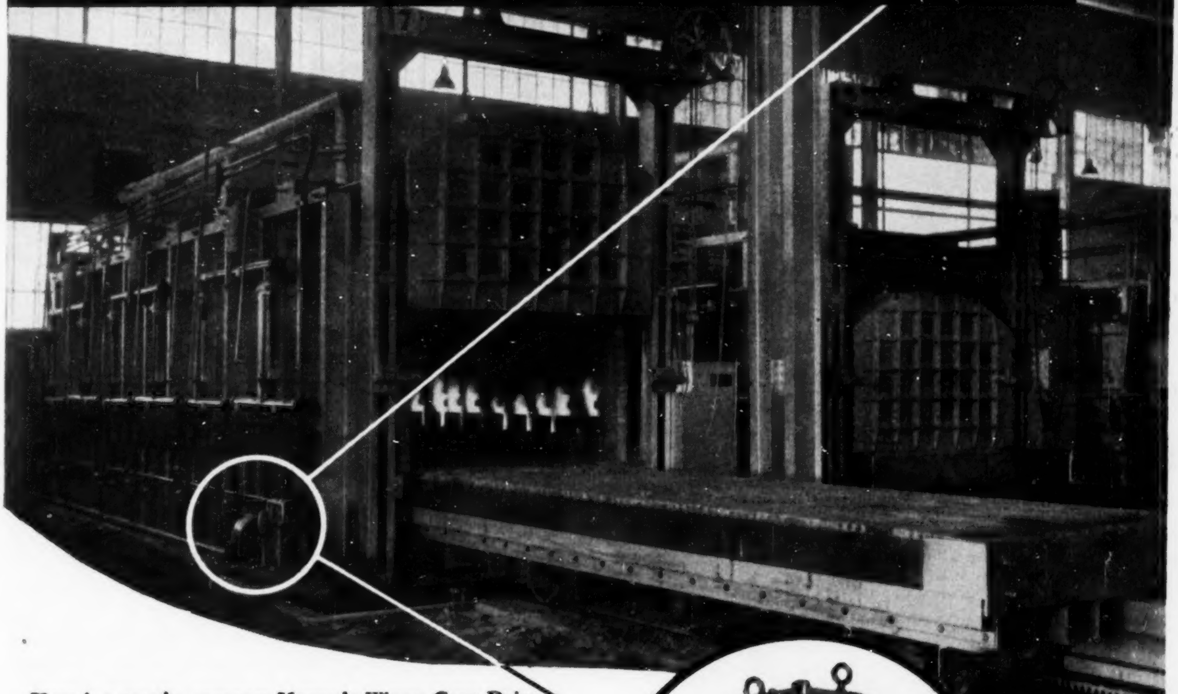
*Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER*

**DIAMOND ROLLER CHAINS**

**FOR RUGGED DESIGN**

**TROUBLE-FREE OPERATION...**

# Choose HYGRADE DRIVES!



Here is a sturdy, compact Hygrade Worm Gear Drive transmitting power for moving heavy cars in and out of a large annealing furnace.

Such tough service is typical of the demands industry is making on Foote Bros. Hygrade Drives. These drives are built for rugged duty — day after day — year in and year out. Precision-processed worm gearing assures highest efficiency and optimum load-carrying capacity. Compact design gives maximum performance in minimum space.

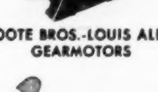
Solve your tough speed reduction problems with Enclosed Hygrade Drives. Horizontal and vertical types available. Ratios to 4,108 to 1, capacities to 260 h.p. For applications requiring long, unsupported output shafts, use Vertical Hygrade in Hytop design.

***See your Foote Bros. representative or write for information***

One of 15 car-type furnaces using Hygrade Drives at Warren, Ohio, plant of Copperweld Steel Company. Installed by Pennsylvania Industrial Engineers Division, Amsler Morton Co.

LINE-O-POWER DRIVES

MAXI-POWER DRIVES



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*Better Power Transmission Through Better Gears*

FOOTE BROS.
GEAR AND MACHINE CORPORATION
Dept. Q, 4545 South Western Boulevard
Chicago 9, Illinois

Please send me a free copy of Bulletin HGB on Foote Bros. Hygrade Worm Gear Drives.

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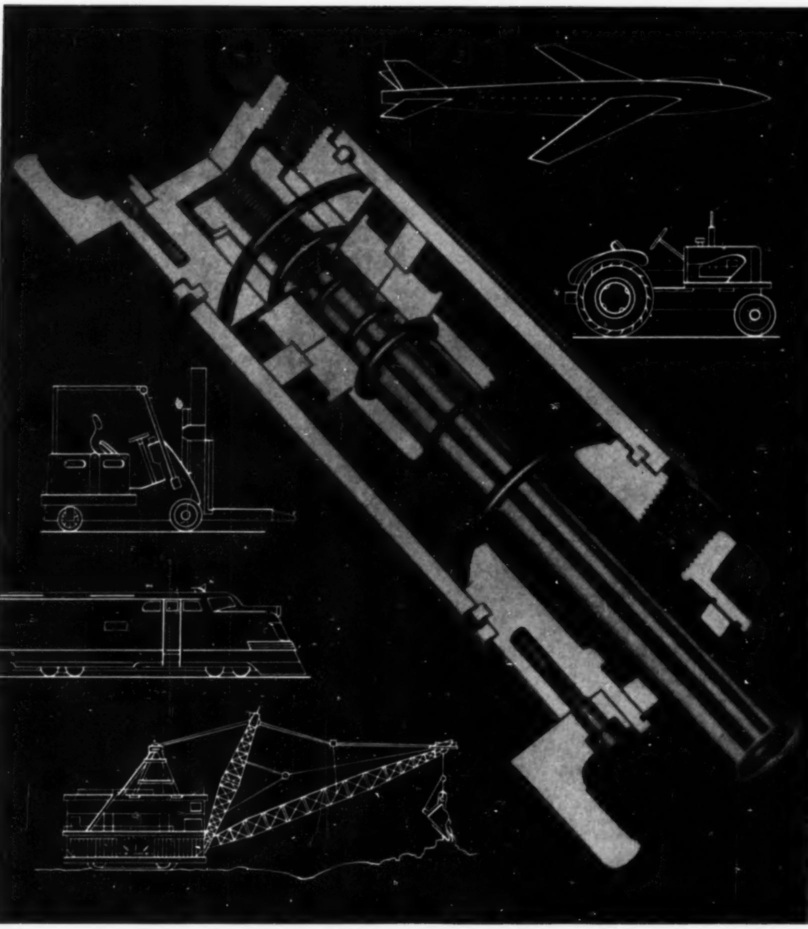
City.......... Zone.......... State..........



Cutaway view of an Ortman Miller Machine Co. Standard Hydraulic Cylinder showing PARKER O-rings.

# Specify PARKER O-rings for economical, leakproof seals

**THIS IS IT**

Cross section drawing of O-ring in groove, sealing under pressure.

For sealing in a hydraulic cylinder . . . or for whatever service you need them, you can get PARKER O-rings, molded of expertly formulated synthetic rubber compounds, that will provide long, trouble-free sealing life. That means they are economical to use. They're economical, too, because they require no complicated design . . . just a simple groove, usually saving space and weight.

PARKER makes *all* standard O-rings for fuel, hydraulic and engine oil services as well as special-service O-rings. Ask your PARKER O-ring Distributor for Catalog 5100, or write The PARKER Appliance Co., 17325 Euclid Ave., Cleveland 12, O.

**Parker**

**TUBE FITTINGS • VALVES • O-RINGS**

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

**Parker O-RINGS**

**ARE STOCKED BY THESE AUTHORIZED DISTRIBUTORS**

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CLEVELAND, O.
Cleveland Ball Bearing Co.
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Air Associates, Inc.
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TULSA, Okla.
Metal Goods Corp.
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Standard Products, Inc.
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Railway & Power Engineering Corp., Ltd.


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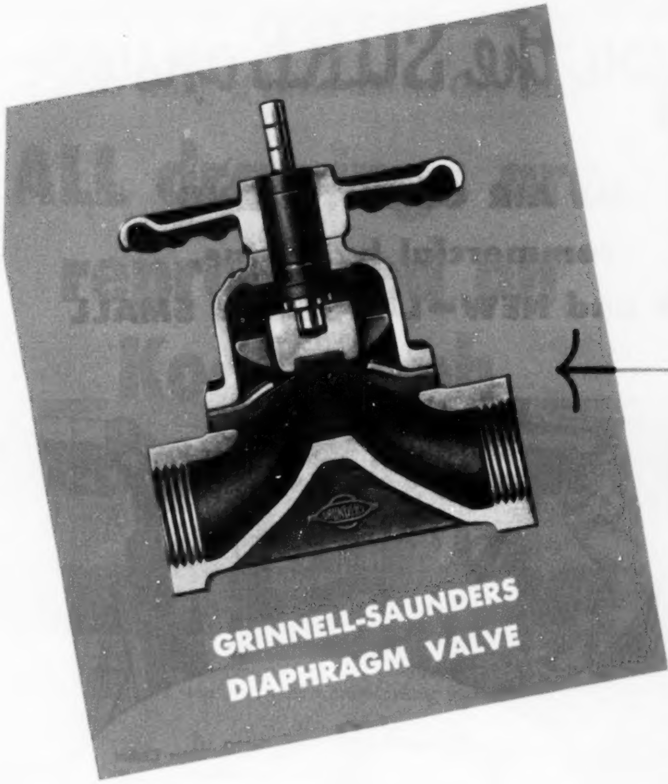
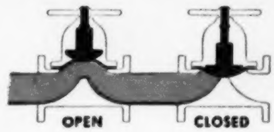
**PARKER** ALUMINUM *and* ZINC *Die Castings*




# The valve originally designed to eliminate

# COMPRESSED AIR LEAKS




***Features which have made Grinnell-Saunders Diaphragm Valves the specified valve in many different industries:***

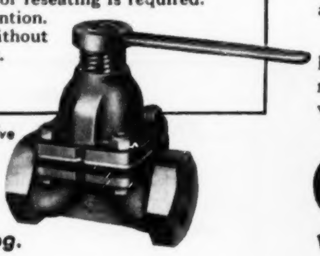
**Streamlined flow.** Smooth, streamlined passage, without pockets, prevents trapping of solids. Frictional resistance is at a minimum — regardless of direction of fluid flow. No disc holder in fluid stream.

**Leak-tight closure against grit, scale, suspended solids.** The resilient diaphragm, plus the large area of contact, gives leak-tight closure against pressure or vacuum.

**Working parts absolutely isolated from fluid.** Diaphragm completely seals off working parts from fluid in the line. No sticking, clogging or corroding of working parts. Valve lubricant cannot contaminate fluids.

**Body, lining and diaphragm materials to meet service condition.** Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum; other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

**Minimum maintenance.** No refacing or reseating is required. No packing glands to demand attention. New diaphragm can be inserted without removing valve body from the line.



*Quick Operating Valve*

***Write for Grinnell-Saunders Diaphragm Valve Catalog.***

A single 1/32-inch leak in an air valve can waste, in one month, the full cost of a Grinnell-Saunders Diaphragm Valve. In fact, that's why Grinnell-Saunders Diaphragm Valves were designed . . . to eliminate costly air leaks. Even when scale in the line becomes lodged on the valve weir, Grinnell-Saunders Valves give positive, air-tight closure.

The operating principle is simple. A rubber diaphragm, seating on metal, makes possible an absolute seal. At the same time, because working parts are wholly isolated, no packing glands are necessary, and stem leaks are impossible.

Successful on compressed air lines, it was only a matter of time before Grinnell-Saunders Diaphragm Valves were in demand for other type installations . . . handling materials as diversified as corrosive fluids, gases, beverages, foods, suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

Grinnell-Saunders Diaphragm Valves can be had with body, lining and diaphragm materials to meet different service conditions. Assign your next valve problem to Grinnell.

# GRINNELL

**WHENEVER PIPING IS INVOLVED**

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
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# SERVEL gives you the SURE answer—

**for AIR CONDITIONING**
**commercial buildings,**
**OLD and NEW—LARGE and SMALL**

Servel 25-ton Water Chiller with no moving parts, operates continuously at peak capacity with minimum maintenance. Simple controls will modulate capacity as much as 50%, with corresponding economy.

**adaptable!** The Servel 25-ton absorption-type Water Chiller, because of its light floor loading and quiet, vibrationless operation, can be installed in a penthouse, on individual floors or in the basement . . . *without special foundations or floor braces.*

**economical!** Used with individual-room chilled water coils, this Servel system needs no expensive duct work—only simple piping. Consequently, installation is much easier—and when remodeling, costs are less.

Steam, from your most economical source, operates the unit. Even waste heat may be used. High operating efficiency is further assurance of low costs. And maintenance is minimized because there are *no moving parts* to wear or grow noisy—factory-guaranteed for five full years.

**easy control!** The Servel system is remarkably flexible! Individual floors or selected areas can be air-conditioned as you choose. Zone control is easily possible with separate units placed where desired, or from a central source.

Let your Servel dealer tell you more about Servel Water Chillers for *Air Conditioning, Process Cooling* and *Industrial Precooling* . . . or mail the coupon for information and engineering co-operation. No obligation.

Servel

*the name to watch for great advances in*

AIR CONDITIONING ✓ REFRIGERATION

**MAIL NOW FOR COMPLETE DETAILS!**

**SERVEL, INC., Dept. ME-6, Evansville 20, Indiana**

Please send me complete information on Servel equipment for ☐ Air Conditioning ☐ Process Cooling ☐ Industrial Precooling

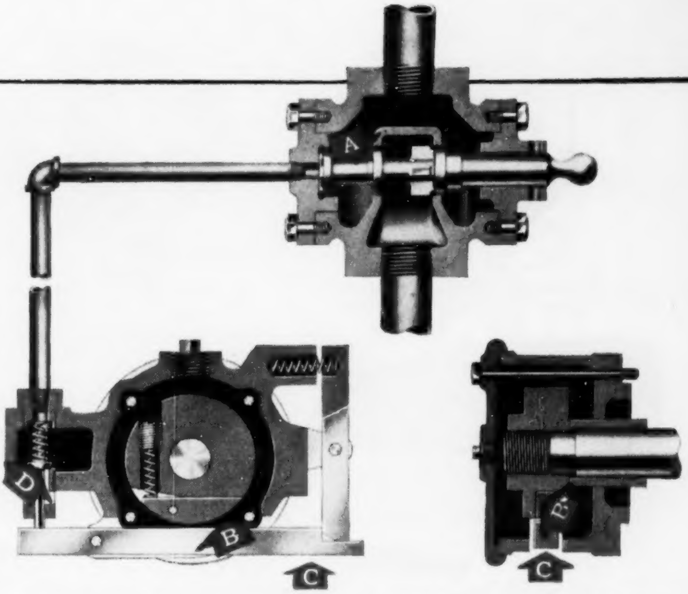
Name____________________

Firm____________________

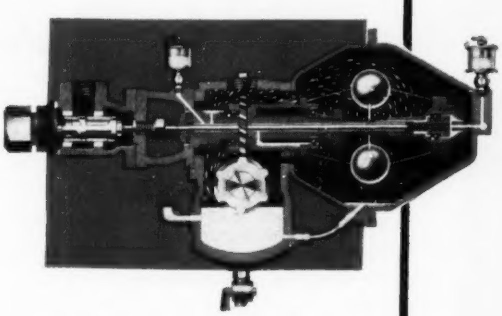
Address____________________

City________ County________ State________

# Only Coppus Turbines offer you *a pilot operated* excess speed safety trip




The constant speed governor on Coppus Turbines, plus this Excess Speed Safety Trip, gives you extra protection for your turbine investments. Here's how it works. When steam is turned on, pressure opens valve A fully. When excess speed is reached, centrifugal force throws weight B against lever C lifting pilot valve D. This releases pressure in back of valve A, closing this valve instantaneously, to shut off the steam. Safety trip can be tested easily while turbine is running by manually tripping and resetting lever C.



Sectional view showing lubricating system of fully enclosed Coppus Constant Speed Governor. Governor head acts directly on stem of steam admission valve. No external levers required. Ball bearing construction eliminates end play and gives frictionless operation.

**Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes**

**CUT YOUR COSTS PER HORSEPOWER**

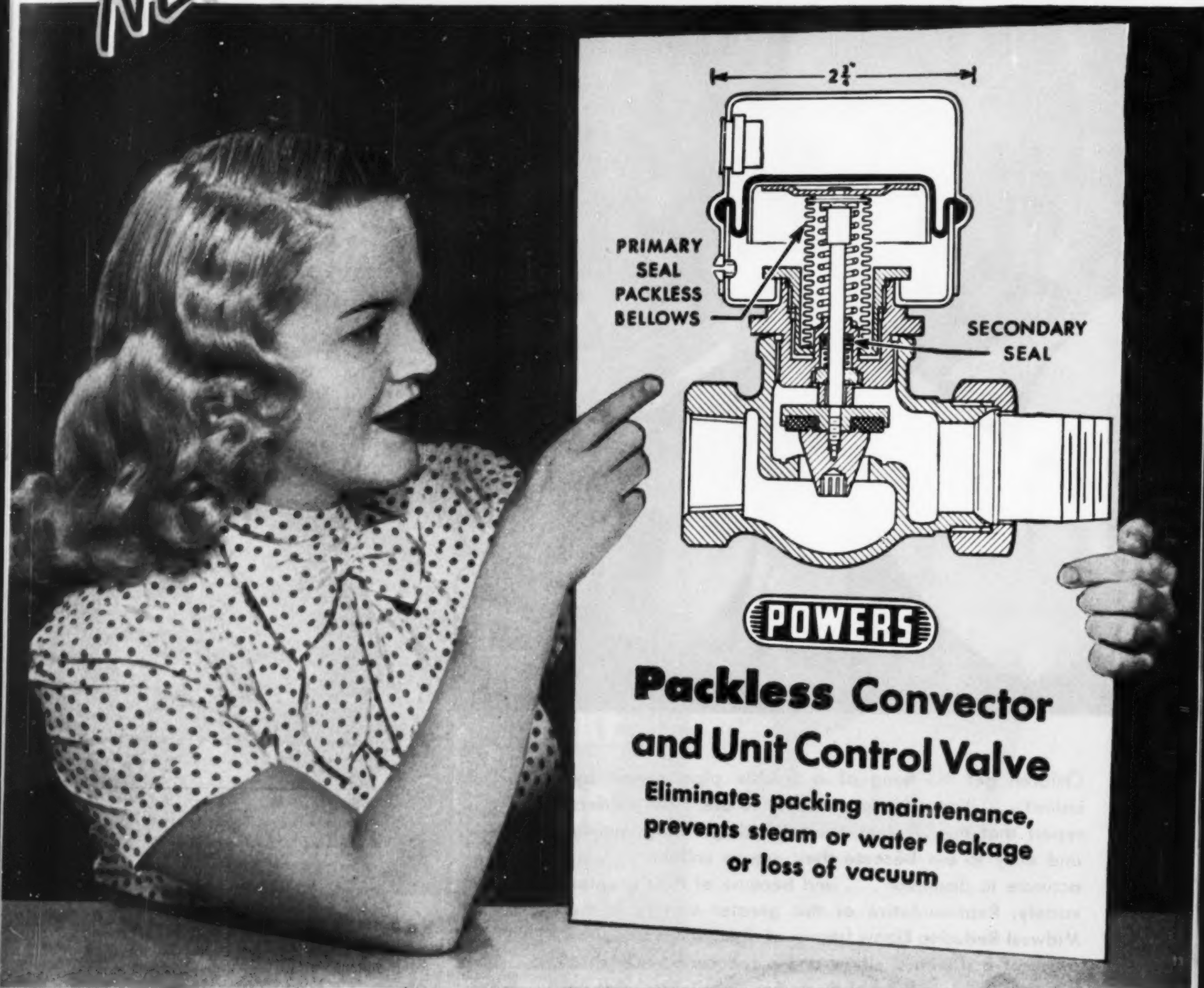
When you choose from the Coppus Steam Turbine line, you get the right size for your requirements . . . and make substantial savings on *any* size from the 150 hp turbine down to the smallest. Low in first cost, Coppus Turbines save you more money in the long run. Operating and maintenance costs are kept low by such other features as: large number of steam nozzles, controlled individually by manually operated valves; hard chromium plating on shaft at the stuffing box; replaceable cartridge type bearing housings; optional carbon ring packing assembly for back pressures up to 75 pounds.

**WRITE FOR BULLETIN 135**

COPPUS ENGINEERING CORPORATION, 366 Park Ave., Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

# COPPUS "BLUE RIBBON" TURBINES

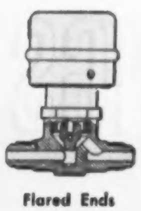
# NEW! POWERS PNEUMATIC *Systems of*



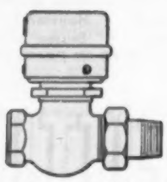

## POWERS - **PACKLESS** - VALVES

*Never require re-packing.*

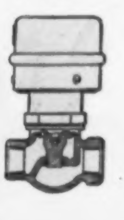
**Real Economy in Maintenance year after year**

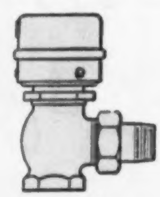


Flared Ends



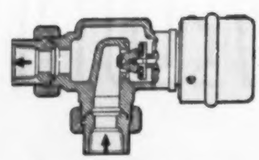
Straightway Union





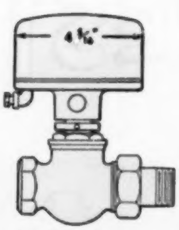
Angle Union

← Screwed Ends

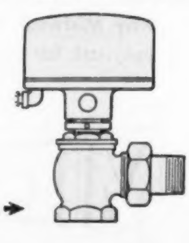


Reverse Flow Double Union

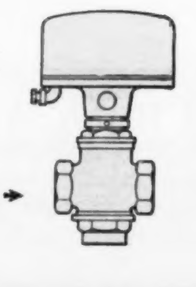
Available in various types and sizes for control of convectors, unit ventilators, unit air conditioners and radiators.




Straightway Union



Angle Union →



3-Way Screwed Ends →

# *Automatic Temperature Control*

## *Now Include*

## POWERS-**PACKLESS**-VALVES

**For Controlling Convectors, Unit Ventilators, Unit Air Conditioners and Radiators.**

**Now, at NO Extra Cost** — users of Powers pneumatic control systems will get the additional benefits of still lower operating and maintenance costs — insured by Powers packless valves.

**Duo-seal Construction Gives Them Superior Performance.** Bronze packless bellows is the Primary Seal which eliminates packing maintenance — packing friction — steam and water leakage or loss of vacuum. Secondary Seal permits servicing of valve top without draining the water system or shutting off the steam supply.

**Banish PACKING Maintenance**

**No Loss of Vacuum**

**. . . leakage of air reduces efficiency of heating system and increases corrosion in return lines**

### Typical Specifications for POWERS-Packless-Pneumatic Control Valves

Control valves for convectors, radiators and unit ventilators shall be packless type with bronze packless bellows to eliminate steam and water leakage or loss of vacuum. This packless bellows shall be located so that it is not subject to corrosive action of the steam or water. A spring-loaded secondary seal shall be provided to permit convenient inspection or servicing of valve top without draining the water system or shutting down the steam supply.

Valve sizes shall be determined by control manufacturer for capacities specified. Type of valve body and valve top to be used shall be as required to best satisfy the application.

Valves shall be equipped with phosphor bronze bellows or Neoprene diaphragms of sufficient size to close off against specified line pressures. Diaphragms shall be replaceable. Valves shall be equipped with characterized throttling plugs to insure a measured flow of steam or water in direct relationship to the demand of the controlling thermostat.

**No Steam or Water Leakage**

**THE POWERS REGULATOR CO.**

**Skokie, Ill. • Offices in Over 50 Cities in the U. S. A., Canada and Mexico**

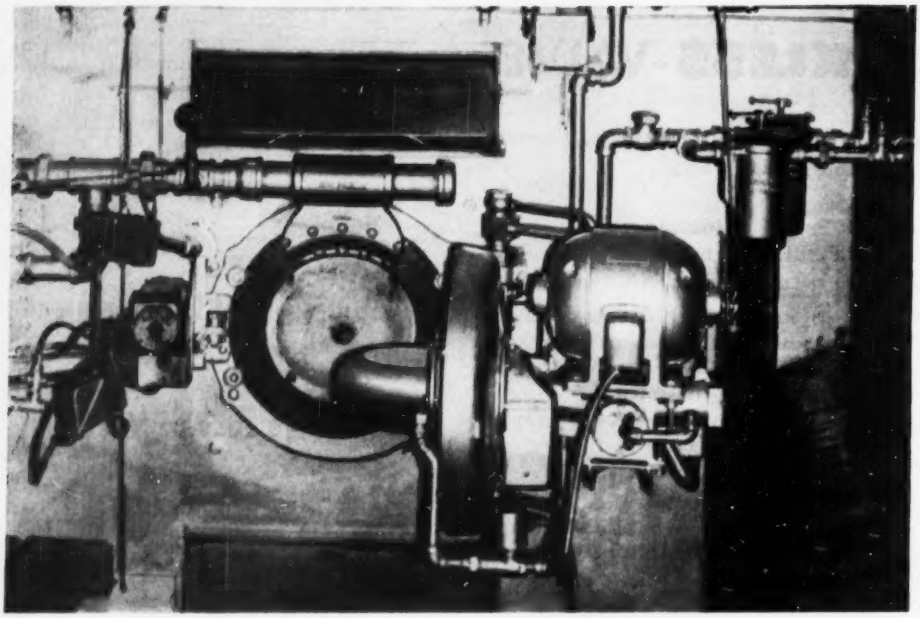
**See Your Phone Book**

OVER 60 YEARS OF AUTOMATIC TEMPERATURE CONTROL

(b18)

Only a Few of **POWERS** Complete Line of Modern Control Valves for Regulating Heating and Air Conditioning Systems

# Change fuels at a moment's notice



MR. JOHN H. MILLER, *General Manager*, New Method Laundry, Columbus, Ohio.

**"Iron Fireman gas-oil firing is profitable investment"**

"Four years ago we installed Iron Fireman gas-oil firing in our 200 horsepower water tube boiler. During peak periods our load often exceeds 150% of rating. Heavy steam demands are required without warning. Iron Fireman gas-oil firing has met the test. The changeover from gas to oil and back again can be made in a few minutes, without interruption. Our steam costs are low, and maintenance is negligible."

At left, Iron Fireman Ring Type gas burner in operation in the New Method Laundry boiler room. Iron Fireman Rotary heavy oil burner is swung back out of firing position.

# Iron Fireman

## Dual or Triple Fuel Firing

### Use GAS, OIL and COAL interchangeably

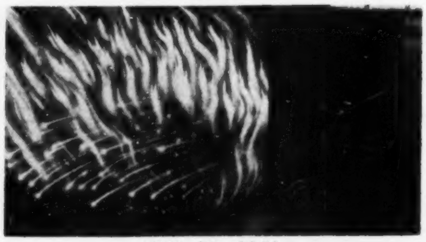
With Iron Fireman firing you can burn any fuel you wish interchangeably—gas-oil, gas-coal, oil-coal, or all three. In woodworking plants any or all of these fuels are successfully combined with a fourth—wood waste.

High combustion efficiencies are obtainable with oil, gas or coal. As price advantage shifts from one fuel to another your steam plant can shift with it—for the long pull if necessary.

Or you can change fuels every day when desirable. This is routine practice in plants where the gas supply is reduced during daily peak periods.

**Avoid costly shut-downs**

Fuel emergencies, due to interrupted or short supply, can be disastrous. Yet protection against such emergencies may cost you little or nothing when offset by the fuel and labor savings of Iron Fireman multiple fuel firing.

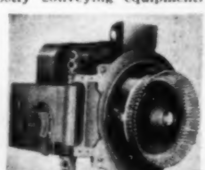


**GAS, OIL, COAL**

Equipment includes Ring Type gas burner, Rotary oil burner, and Pneumatic Spreader stoker. Coal is automatically dried, pre-heated and conveyed from bunker to boiler. No manual handling; no costly conveying equipment.

**GAS-OIL PACKAGE UNIT**

For Scotch marine and other types of boilers. Has integral forced draft and control panel wired and tested at factory.



**GAS-OIL BURNER**

Ring Type Gas Burner and Rotary Oil Burner on single mounting. Fuels can be shifted instantly.

**Send for full information**

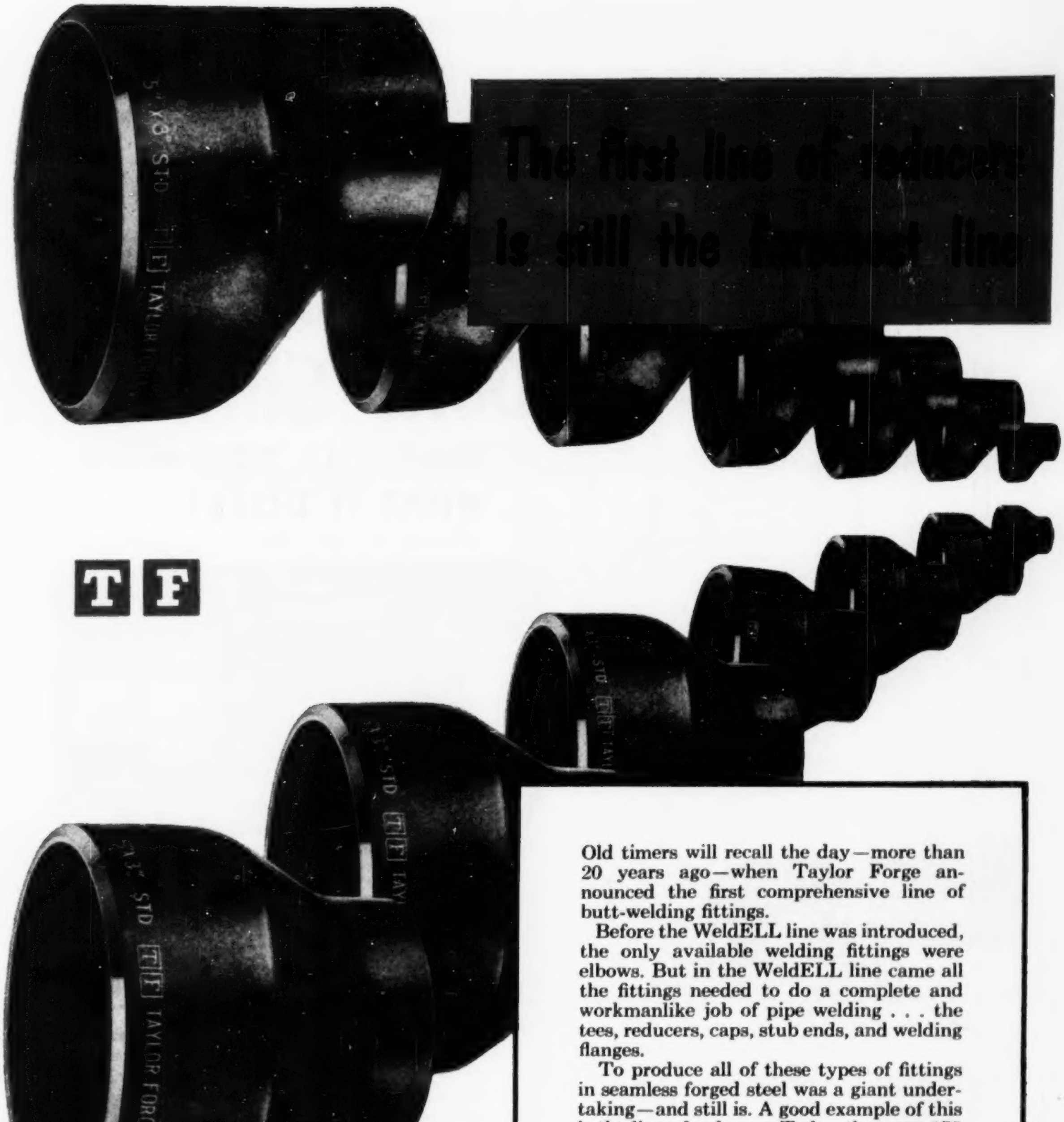
IRON FIREMAN MANUFACTURING CO.
3061 W. 106th St., Cleveland 11, Ohio
Please send literature on Iron Fireman multiple fuel firing.

Name..........................................

Address..........................................

City.............................. State..........

**AUTOMATIC FIRING FOR HOMES, BUILDINGS, INDUSTRIAL PLANTS**



# The first line of reducers is still the foremost line

TF

Old timers will recall the day—more than 20 years ago—when Taylor Forge announced the first comprehensive line of butt-welding fittings.

Before the WeldELL line was introduced, the only available welding fittings were elbows. But in the WeldELL line came all the fittings needed to do a complete and workmanlike job of pipe welding . . . the tees, reducers, caps, stub ends, and welding flanges.

To produce all of these types of fittings in seamless forged steel was a giant undertaking—and still is. A good example of this is the line of reducers. Today there are 175 reductions in standard weight reducers alone—and this can be multiplied by all the weights and materials in which Taylor Forge reducers are available.

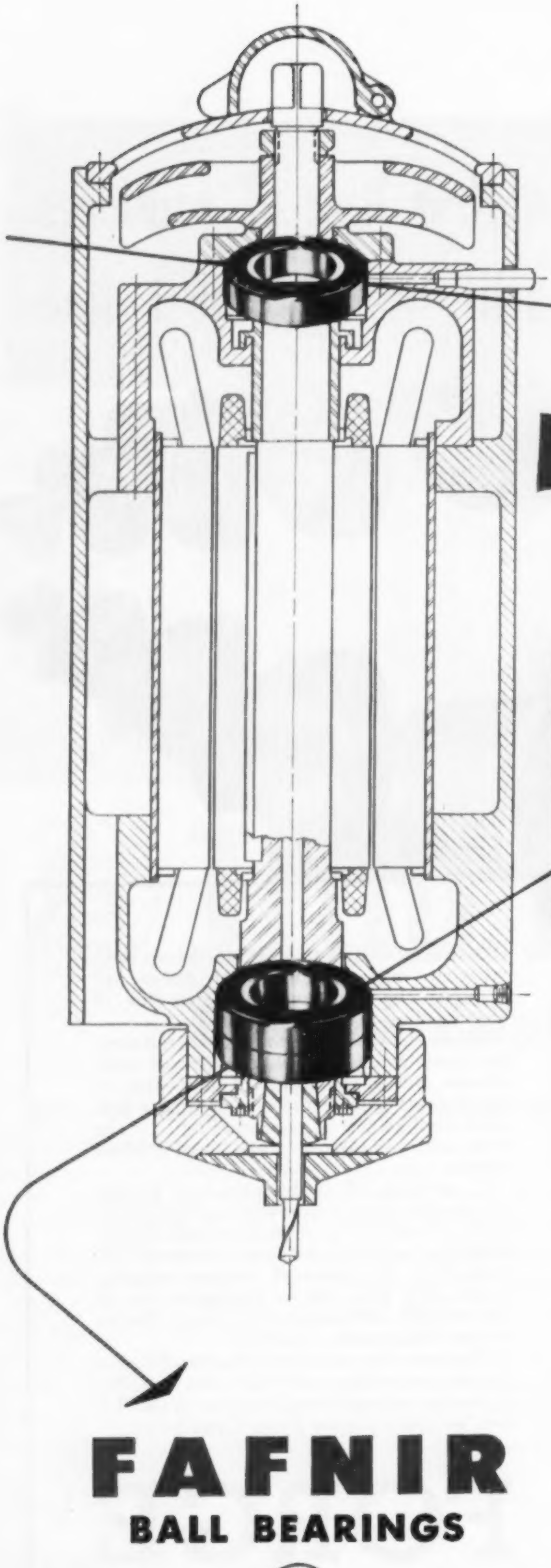
The first line is still the foremost line—the engineered line, the full value line. For up-to-the-minute facts about the WeldELL line, see your Taylor Forge Distributor.

# TAYLOR FORGE

**TAYLOR FORGE & PIPE WORKS**

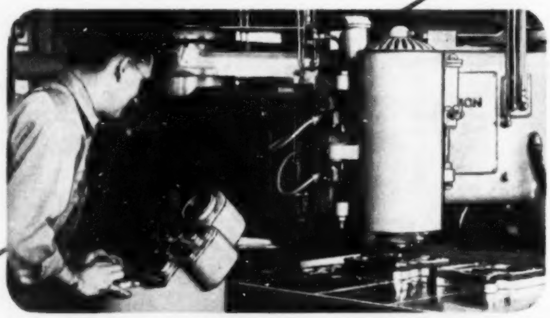
General Offices & Works • Chicago 90 • P. O. Box 485

Plants at: Carnegie, Pa., Fontana, Calif., Gary, Ind., Hamilton, Ont., Canada



# LOOKS SIMPLE

## WAIT TILL YOU HEAR WHAT IT DOES!



High-speed, remote controlled router made by Ekstrom, Carlson & Company, Rockford, Illinois.

You guessed it. This is a blueprint of a spindle head. It shows the arrangement of Fafnir Super-Precision Ball Bearings . . . a single bearing at the top and zero preload, duplexed bearings at the work end. What's unusual about it? Listen to this . . .

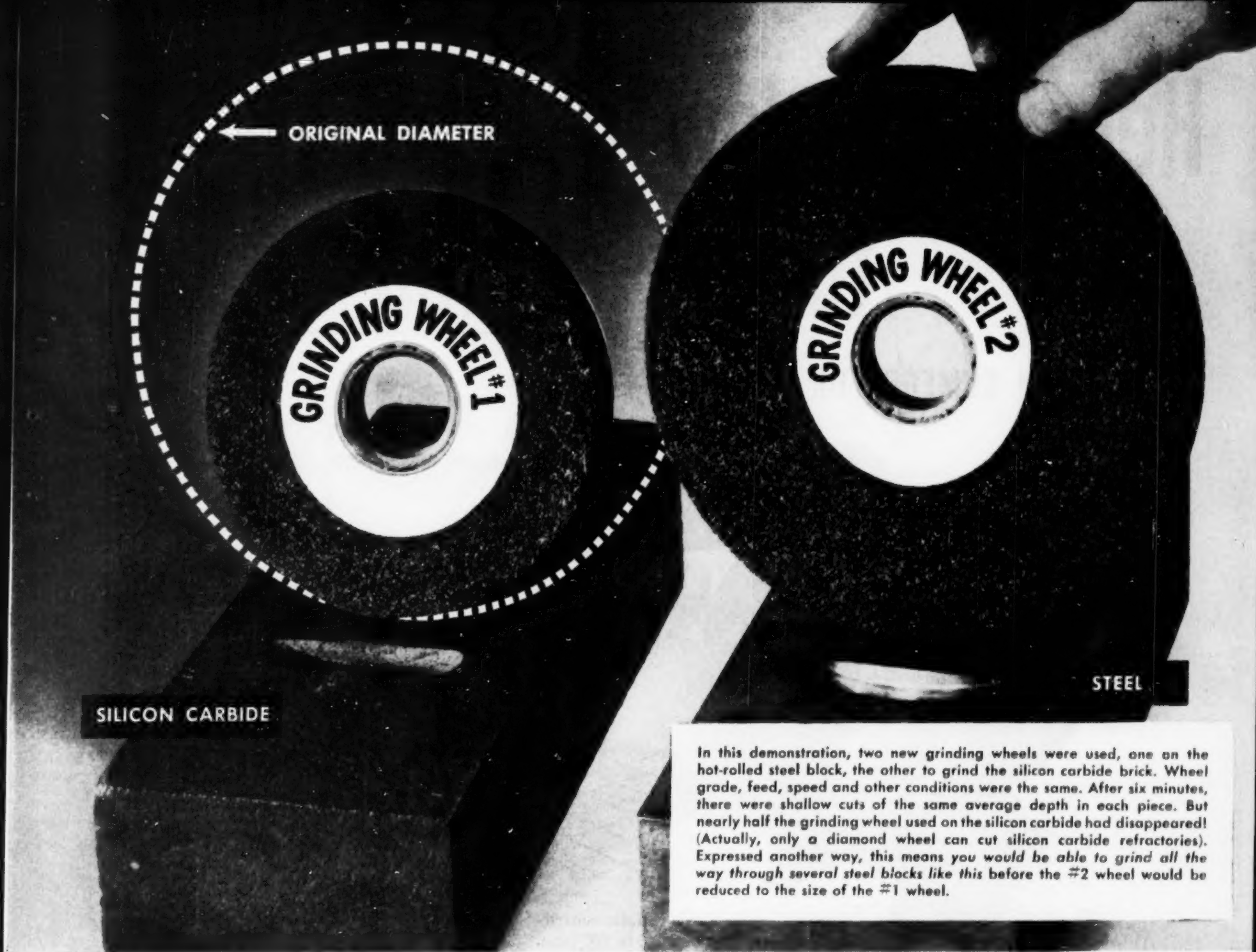
The spindle head is part of an Ekstrom, Carlson high-speed, remote-controlled machine that template routes through 1-inch aluminum plate with a single pass and at cutting speeds as high as 90 inches per minute. It is driven by a 30 h.p. variable speed motor and operates up to 15,000 r.p.m. The radial load on the bearings is as high as 500 to 600 pounds. The spindle head takes tool bits with diameters from 5/16" to 3/4".

Although the top design achievement of this new machine tool is its electrically-controlled hydraulic feed mechanism, the spindle bearing application is no ordinary accomplishment. Fafnir engineers worked hand-in-hand with Ekstrom, Carlson engineers to make it successful. Another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designers' viewpoint, an aptitude for supplying the right bearing to fit the need. The Fafnir Bearing Co., New Britain, Conn.

# FAFNIR

## BALL BEARINGS

MOST COMPLETE LINE IN AMERICA




In this demonstration, two new grinding wheels were used, one on the hot-rolled steel block, the other to grind the silicon carbide brick. Wheel grade, feed, speed and other conditions were the same. After six minutes, there were shallow cuts of the same average depth in each piece. But nearly half the grinding wheel used on the silicon carbide had disappeared! (Actually, only a diamond wheel can cut silicon carbide refractories). Expressed another way, this means *you would be able to grind all the way through several steel blocks like this* before the #2 wheel would be reduced to the size of the #1 wheel.

**harder than steel, more abrasion-resistant than paving blocks—silicon carbide is...**

# so hard it wears out grinding wheels

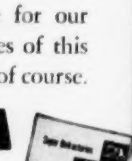
As hard as steel is, it can't compare with our silicon carbide refractories (trademarked CARBOFRAX®). Used under the toughest abrasion conditions known, these refractories have repeatedly proved able to outwear other normally durable lining materials. *This applies to room-temperature applications as well as to others ranging up to 3000 F. or more.* It applies to abrasion caused by rubbing or sliding, and to abrasion caused by impingement of sharp particles traveling at high velocities.

For example: In cyclone dust collectors where there is a constant blast of highly abrasive particles . . . in coke chutes and hoppers that must withstand punishing cascades of sharp-edged coke . . . in hot blast mains where abrasive dust is entrained in high-velocity gases . . . in billet heating furnaces where metal slabs are dragged across the floor. In short, wherever other materials need replacement so often as to make their use uneconomical.

Have you any spots like these; areas highly vulnerable to abrasion? Then check on these CARBOFRAX refractories. Available as tile, brick or special, close-tolerance shapes, these materials can give your equipment "armor-plate" protection. They are particularly valuable where heat or chemical action may be teamed with abrasion. Write for our booklet that describes all the interesting properties of this and other unique super refractories. No obligation, of course.

**CARBORUNDUM**

Registered Trade Mark

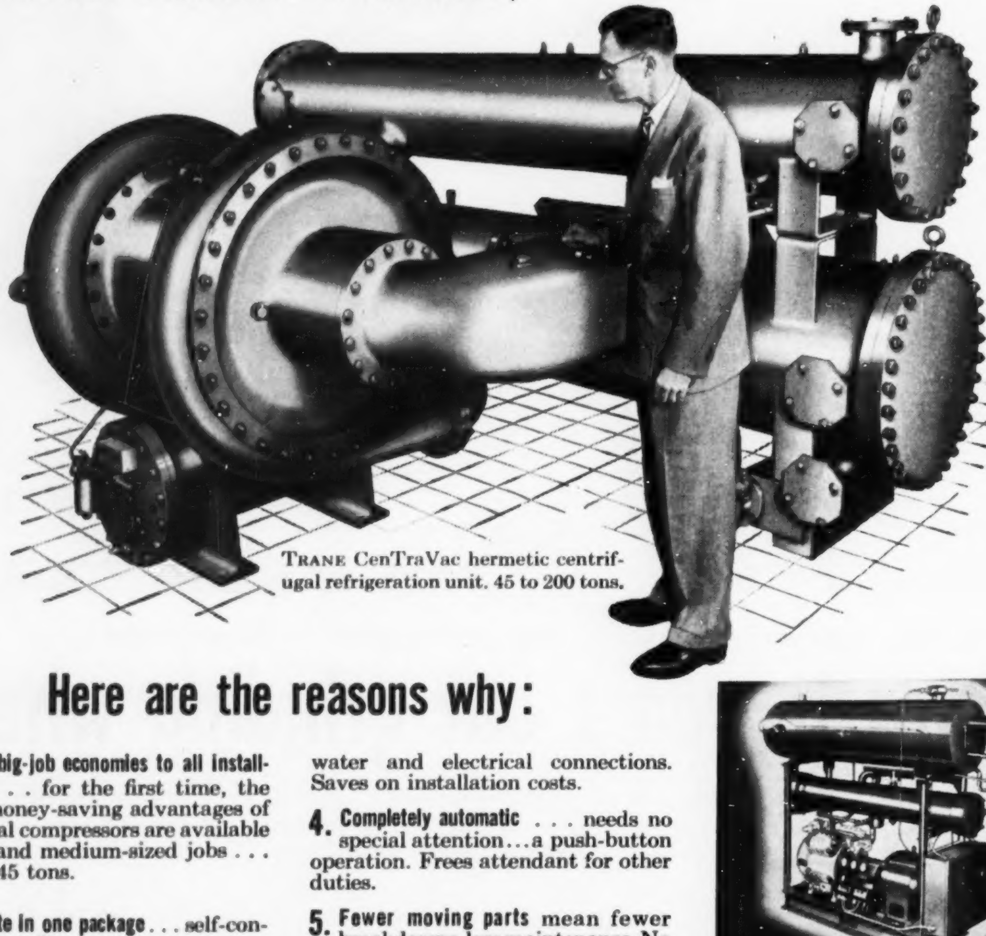


**Dept. P-63, Refractories Division**
**The Carborundum Company, Perth Amboy, N. J.**
**Send complimentary copy of Super Refractories booklet to:**

NAME____________________
POSITION____________________
COMPANY____________________
STREET____________________
CITY__________ ZONE____ STATE____

# Here's the low cost way to get chilled water

## (FOR EITHER COMFORT OR PROCESS)



TRANE CenTraVac hermetic centrifugal refrigeration unit. 45 to 200 tons.

## Here are the reasons why:

1. **Brings big-job economies to all installations** . . . for the first time, the proved money-saving advantages of centrifugal compressors are available to small and medium-sized jobs . . . down to 45 tons.

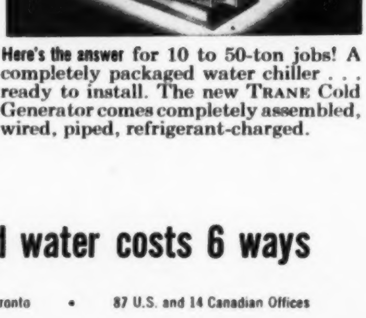
2. **Complete in one package** . . . self-contained . . . all components are perfectly integrated, therefore operate more efficiently (at less cost).

3. **Easier to install** . . . light, compact . . . needs no special base, only simple water and electrical connections. Saves on installation costs.

4. **Completely automatic** . . . needs no special attention . . . a push-button operation. Frees attendant for other duties.

5. **Fewer moving parts** mean fewer breakdowns, less maintenance. No shaft seals or gear boxes at all. Only *one* major moving part.

6. **Built-in automatic capacity control** permits operation down to 10% of rated capacity . . . saves power.

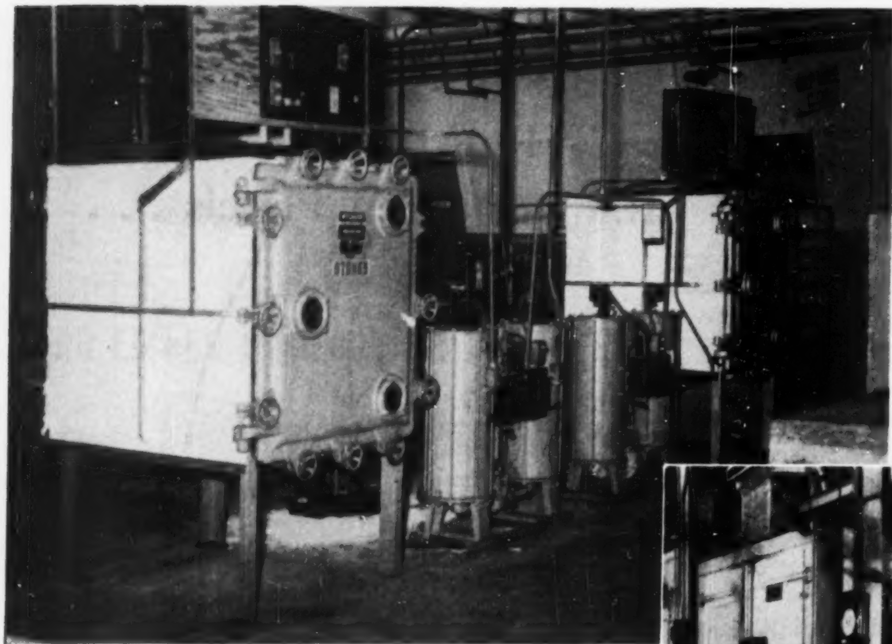


**Here's the answer** for 10 to 50-ton jobs! A completely packaged water chiller . . . ready to install. The new TRANE Cold Generator comes completely assembled, wired, piped, refrigerant-charged.

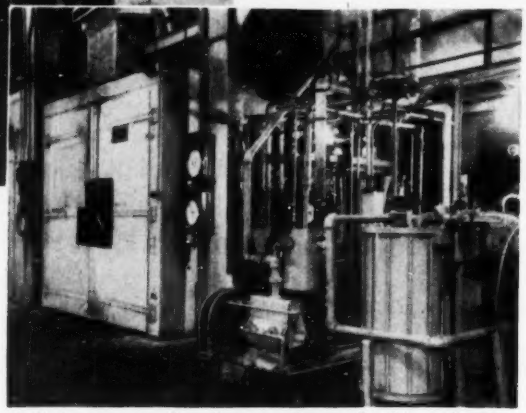
## TRANE CenTraVac cuts chilled water costs 6 ways

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING AND VENTILATING EQUIPMENT



DRY air breaks the vacuum in these ovens, flushes out unwanted moisture, then is sealed into automatic control parts. Such dryness eliminates any possibility of internal corrosion.



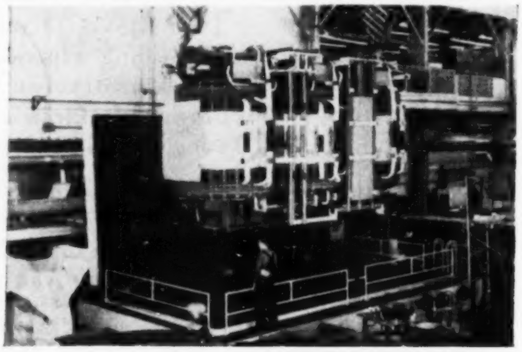
Walk-in oven used to dry transformer bushings. Lectrodryer processed air flushes through the bushings prior to filling, assuring perfect freedom from unwanted moisture.

# Get Rid of UNWANTED MOISTURE!

## WITH LECTRODRYERS*...

Small space or large . . . from vacuum ovens to walk-in ovens to huge workrooms . . . there are Lectrodryers to supply DRY air continuously, automatically, economically. Drying work areas to 10% relative humidity is not uncommon.

Our engineers have solved hundreds of moisture problems for manufacturers. Their experience may help you. Write: Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pennsylvania.



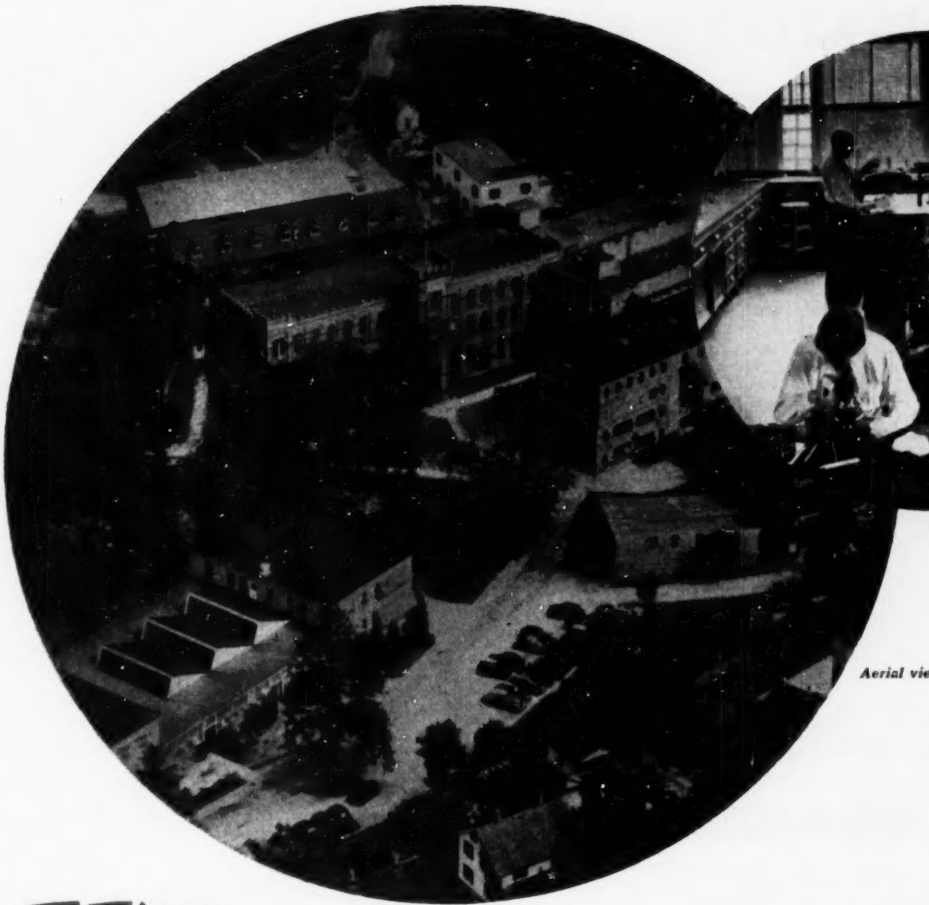
When the door is closed, the tank will be flooded with heated, DRY air. All unwanted moisture is evacuated, then immediately the transformer is transferred to its own container and sealed. This assures maximum insulation quality. Lectrodryer, of course, supplies the required DRY air.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

**LECTRODRYER**

*REGISTERED TRADEMARK U.S. PAT. OFF.



*Part of the Engineering and Research Laboratory*

*Aerial view of Glenville Plant*

# FELT problems are welcomed here —AND SOLVED!

American makes felt in actually hundreds of different types, each having carefully-controlled characteristics. Felt, you see, is not just felt, but is an engineering material, which can be, and should be, selected and specified as closely as any other material.

American is keenly progressive and has a vast knowledge of all types of natural and synthetic fibres. Felt is now engineered into the various end uses. Our knowledge is freely available to you, through our sales staff, or from the Engineering and Research Laboratory.

How important it is to obtain the right felt is illustrated by the case of a customer who insisted on "saving money" by buying a felt which we insisted was not suitable for the application. In the end, the saving produced a loss, and the customer, having learned the hard way, now relies upon our advice. You can avoid such trouble by bringing your needs for felt to American. Tell us what the felt is to be used for, whether in a process or a product, and we will help you select the right type.

And remember, American operates cutting shops in Glenville, Conn., Detroit, Mich., San Francisco, Calif., which can quickly produce cut felt parts, ready for assembly, to speed your output.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN. SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

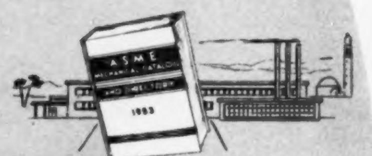
# From **KALAMAZOO** to **ISTANBUL**

## 15,000*

## Mechanical Engineers

## report:

**ISTANBUL, TURKEY**



***"We use the catalog as a reference source for manufacturers of machinery and equipment which we import from the U.S.A."***

***—Consulting Engineer***

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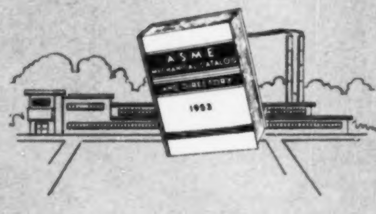
**FOREST HILLS, LONG ISLAND**



***"When in doubt as to which of two similar products to use, I use the one in the catalog."***

***—Methods Engineer***

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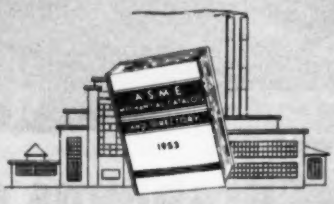
**KALAMAZOO, MICHIGAN**



***"The Catalog and Directory has been of assistance in locating the names of manufacturers of specific equipment."***

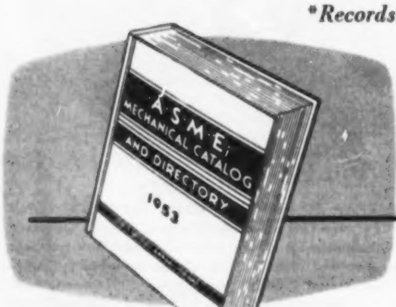
***—Director of Industrial Engineering***

**In addition to 50,000 listings of more than 6,500 products and 4,600 manufacturers, your ASME Mechanical Catalog and Directory contains 385 pages of charts, photographs and detailed drawings to aid you in product selection and specification.**

**Cross indexed to save valuable time in locating suppliers of anything from absorbers to zinc oxides, the catalog has proved its usefulness to engineers since 1911.**

**No matter where you are, no matter what product you are searching for, consult your ASME Catalog often. You're sure to agree that it is indeed "the best of references."**

****Records indicate that each of the 15,000 copies distributed is consulted by 3 to 5 persons.***




# MECHANICAL CATALOG and Directory

**THE BEST OF REFERENCES FOR THE MECHANICAL ENGINEER**

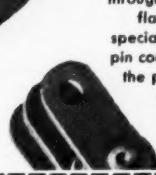
***Another service performed by ASME for its members!***

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**
**29 West 39th Street, New York 18, N. Y.**


Maybe you can find a use for Improved Baldwin Assembly Multiple Width Riveted Roller Chain... IF you want to save money...save customers costly down time...speed up chain assembly in *your* and your *customers'* shops...simplify chain inventory and stocking!

It's not particularly sensational...just the handiest, most usable riveted roller chain yet! Here's all there is to it. It's just a ten-foot strand riveted multiple width chain with exclusive Single Pin Couplers installed at convenient intervals in the strand, so that any length of chain may be made up in a hurry without cutting the chain or damaging chain parts. It's just as easy to couple and uncouple as cottered chain. BUT the entire strand retains the added life of riveted chains. Your shop can install these chains in a hurry AND your customers can do the same, so they save plenty by cutting "down time." Chain is shipped in boxes with a ten-foot assembled length in each box. Or, it can be *made up* in any length you specify. Why not send for the complete story? Just mail the coupon.


**HERE IT IS:** One end of the single pin coupler link is firmly riveted to the adjacent link (1). The unique coupler pin (2) has a spun washer (3) on one end, the other has a milled flat (4) and locking pin. The pin is an easy fit through the chain except for the milled flat end which is press-fitted into a special matching hole (5) of the single pin coupler plate. You need only drive the pin the length of its milled flat in assembling or disassembling the chain. It's easy . . . saves time, effort and money.



**BALDWIN-REX**

**ROLLER CHAINS**

**A PRODUCT OF**

**Chain Belt COMPANY**

**OF MILWAUKEE**

53-405

CHAIN BELT COMPANY
Baldwin-Duckworth Division
363 Plainfield Street
Springfield 2, Mass.

Gentlemen:
Please send my copy of Bulletin No. 52-2

*Name*..................................................

*Firm*..................................................

*Address*..................................................

*City*.............................*Zone*......*State*.......

# LORD MOUNTINGS...


The unique Lord application illustrated above accommodates controlled orbital motion of the sanding head in the Porter-Cable #106 Finishing Sander. "Lord Bonded-Rubber Mountings", Porter-Cable reports, "outlast any mountings previously used because of the excellent bond between rubber and metal" and thus contribute much to the efficient operation of this popular Porter-Cable unit. You may have a similar problem to solve in the products you manufacture. Your request for information is invited. We will be pleased to consult with you on the application to your products of Lord Vibration and Shock Control Mountings and Bonded-Rubber parts.

| | | | |
|---|---|---|---|
| BURBANK, CALIFORNIA<br>233 South Third Street | DALLAS, TEXAS<br>413 Fidelity Union Life Building | PHILADELPHIA 7, PENNSYLVANIA<br>725 Widener Building | DAYTON 2, OHIO<br>410 West First Street |
| DETROIT 2, MICHIGAN<br>7310 Woodward Ave. | NEW YORK 16, NEW YORK<br>280 Madison Avenue | CHICAGO 11, ILLINOIS<br>520 N. Michigan Ave. | CLEVELAND 15, OHIO<br>Room 811 Hanna Bldg. |

**LORD MANUFACTURING COMPANY • ERIE, PA.**

LORD BONDED RUBBER — *Headquarters for* **VIBRATION CONTROL**

## Lord Mountings Perform Unique Function On Porter-Cable Portable Sander

One of the most unusual requirements for the application of Lord Bonded-Rubber parts is that of the Porter-Cable Portable Sander 106. Here the orbital action of the sanding component must be held within certain limits by the use of flexible rubber mountings fixed to the four corners of the upper housing and the sanding component. High speed operation is necessary for achieving the desired smoothness of surface on materials to be sanded.

Previously used mountings worked well for a time and then failed. The problem of longevity was put up to Lord Headquarters for Vibration Control in Erie, Pa.

Analysis of the problem showed that the correct rubber compound bonded to threaded metal studs would offer the desired flexibility with reasonable possibility of longer service life and subsequently less failures. Many tests were completed before adopting the mounting shown in the accompanying advertisement. All objections to the operation of previous mountings were removed by this consultation with Lord Engineers and the results of their efforts. This is but another of many such typical solutions of the vibration problems of appliance manufacturers. These problem solutions include correct mounting of spin dryers on automatic washing machines, isolation of transmitted vibration through fan hubs of room air conditioners, the mounting of mixing and blending equipment used by the modern housewife—in fact, wherever vibration and shock present an obstacle to satisfactory machine operation Lord Vibration Control Mountings are being engineered for the job. The experience of more than a quarter century in dealing with vibration and shock problems is available to you in the solution of vibration problems. Your efforts to improve the operation of your product by controlling or isolating vibration will be more effective when you consult with Lord Manufacturing Company, Erie, Pa.

### New Lord Lattice Mounting Used To Advantage On Heavy Industrial Machines

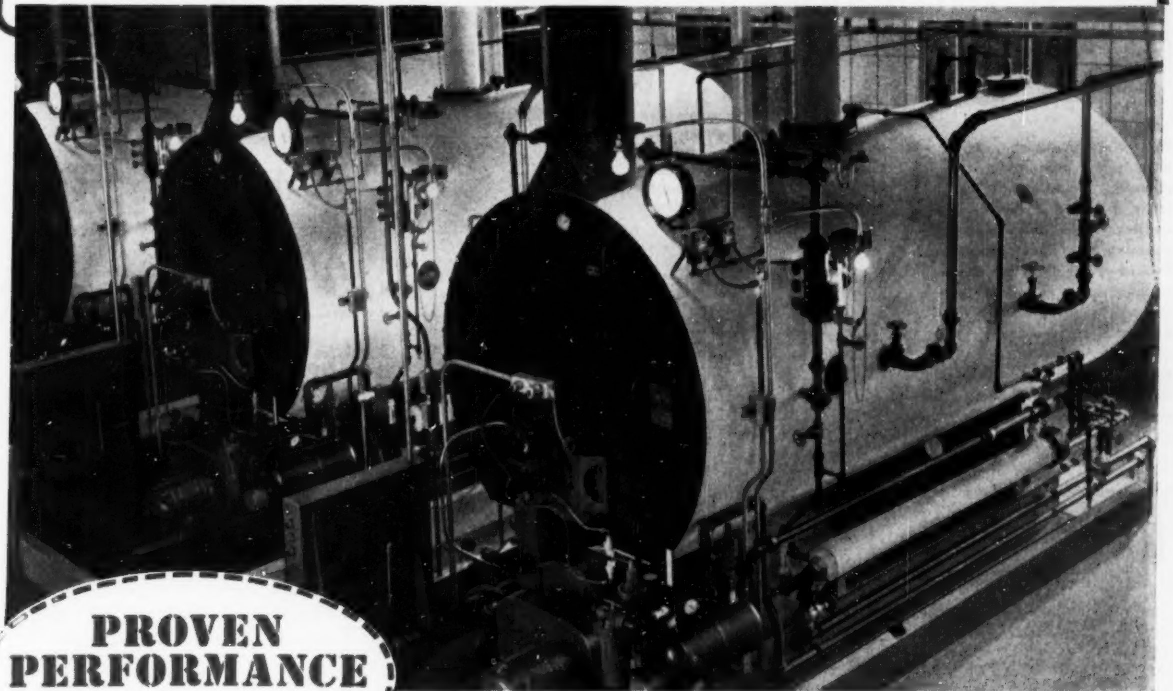
The Lord lattice mounting incorporates many features of value to designers of heavy industrial equipment. These mounts are now being used for support of Foundromatic Shakeouts and Aero-Vibe Screens manufactured by Allis Chalmers. Other applications include reciprocating or rotating machinery requiring a high degree of vibration isolation. The load range for a lattice type mounting is 250-2000 pounds per mounting point.

The lattice design of the rubber section permits the load to be carried by the rubber in shear . . . the softest practical type of support. Lattice type mountings offer more stability in the horizontal plane. No lubrication is required thus lowering maintenance costs. Since there are no steel surfaces in contact, quieter operation is possible. The rubber section also offers greater isolation of noise that is easily transmitted through steel springs. The inherent damping of the rubber reduces the excursion of screen in passing through resonance on starting and stopping. No mechanical dampers are required.

The lattice type mounting offers excellent vibration isolation for the lower range of disturbing frequencies. For very low operating speeds, the mountings may be installed in series. The lattice type mounting also accommodates large amplitudes of motion.

The lattice design is another instance where Lord experience in vibration and shock problems has proved valuable to manufacturers. Consult with Lord engineers early in the design phase of your products. Lord's vast reservoir of experience is yours for the asking.

# Cleaver-Brooks boilers save $25,000 per year for Hoosac Mills...pay for themselves in 2 years' time!



**PROVEN PERFORMANCE**

ANOTHER OUTSTANDING REPORT FROM A CLEAVER-BROOKS OWNER

After installation and starting service was completed, a check was made on boiler output. Tests indicated efficiency exceeded the guaranteed 80%. After eight months' operation without tube cleaning, stack temperature showed no noticeable gain, indicating high efficiency had been maintained. *Planned and installed by Frank I. Rounds Co., Newton Highland, Mass.*

Installing 3 Cleaver-Brooks self-contained boilers at Hoosac Textile Mills, New Bedford Division, was a major step in ending boiler worries. Hoosac can count on yearly savings of $25,000, and they're set up for future expansion as well.

Before deciding what type of boilers to install for replacing old, hand-fired boilers, Hoosac carefully considered these factors:

1. **Efficiency of steam generation** — the cost for supplying 12,000 lbs. of steam required each hour at peak capacity for heating and processing.
2. **Saving labor costs** — through safe, automatic operation.
3. **Cleanliness** — important to textile manufacture.

A study of past performance and prominence of similar units in the industry — showed that Cleaver-Brooks self-contained boilers would fill the bill.

Guaranteed 80% thermal efficiency was one of many influencing factors in selecting the 3 Cleaver-Brooks 150 hp. boilers. Even with loads as low as 30% of rating, these boilers operate with a flat 80% efficiency. (Hoosac operates their plant over widely fluctuating loads, particularly in summer.)

That they attained their objectives is borne out by these results — *results which showed the boilers paid for themselves in 2 years' time.*

1. **$15,000 savings in fuel** — fuel cost studies showed 275,000 gals. of oil at 5½¢ per gal. provide steam for a year's operation. Same steam formerly required 2,000 long tons of coal at $15.00 per ton.
2. **$10,000 savings in labor costs** — fully automatic operation minimized boiler maintenance. Personnel were then available for productive plant work.
3. **Cleanliness** — modern boiler room proved more efficient than previous cluttered arrangement. Hand firing, removal and disposal of fly-ash was eliminated.

In addition to these substantial savings, the installation provided for economical future plant expansion. At present, boiler operation is rotated so all three periodically receive the same service and maintenance.

Cleaver-Brooks boilers are showing similar savings in many other businesses. Investigate — write for Catalog AD-100 and complete information on standard size oil, gas, combination oil/gas fired Cleaver-Brooks boilers, 15 to 500 hp., 15 to 250 psi.

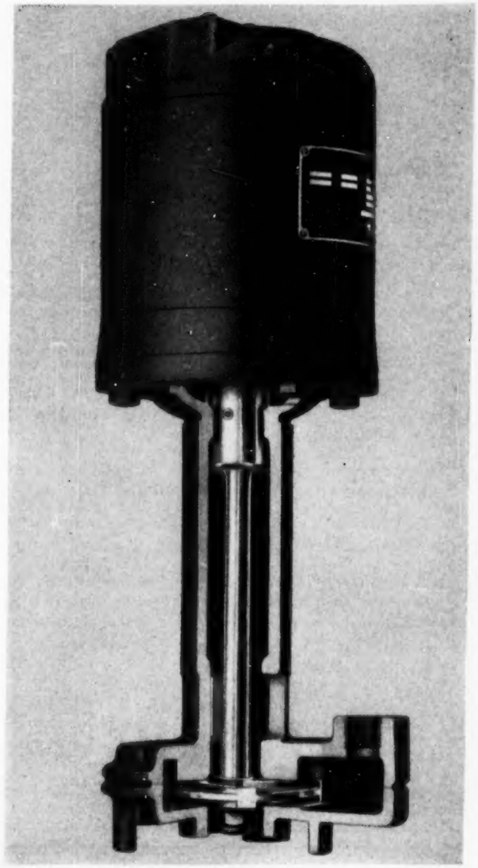
CLEAVER-BROOKS COMPANY
Dept. G, 319 E. Keefe Ave.,
Milwaukee 12, Wis., U.S.A.

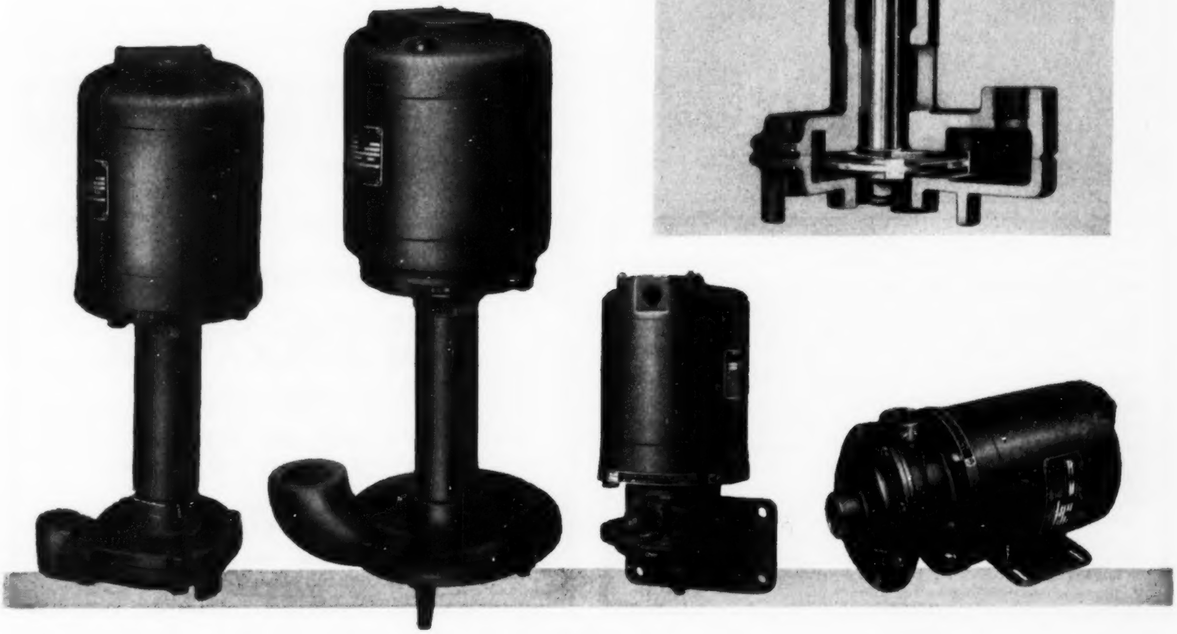
**Cleaver-Brooks**

ORIGINATORS OF THE SELF-CONTAINED BOILER

Steam Boilers • Oil and Bitumin Tank Car Heaters • Distillation Equipment Oil and Gas Fired Conversion Burners

# Motor-Driven Centrifugal Pumps That Dirt Can't Hurt!





Here's a complete line of ten different Motor-Driven Centrifugal Pumps that are completely protected from damage by dirt or abrasives. Hydraulically balanced, their design provides stability without using a bearing at impeller end of shaft . . . eliminates metal-to-metal contact below water level. All motors are of standard NEMA design, for easy replacement, and totally enclosed against dust or vapor . . . no lubrication or maintenance required.

You'll find that the design simplicity and sound construction of these Brown & Sharpe Pumps makes them ideal for countless applications where grit or foreign substances may be present. Write for Pump Catalog. Brown & Sharpe Mfg. Co., Providence 1, R.I., U.S.A.

**BUY THROUGH YOUR LOCAL DISTRIBUTOR**

BS

**Brown & Sharpe**

MECHANICAL ENGINEERING

May, 1953 — CARD INDEX — Vol. 75, No. 5



*For Reference*

**A 20-PAGE LIST OF ASME PUBLICATIONS**

is included in the

**1953 ASME MECHANICAL CATALOG AND DIRECTORY**

*Copies of the List are obtainable from*

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

*Publication-Sales Dept.*

**29 West 39th St., New York 18, N. Y.**

MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Additional information is requested on the following advertisements in the June 1953 issue

*Page No.* ____ *Name of Advertiser* ____

Name ____ Title ____

Company ____

Address ____

City ____ State ____

## Reader Service Coupon For More Information

Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

# OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

***Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.***

## POSITIONS OPEN

## ENGINEERS

### ASSOCIATE ENGINEERS

•

**MECHANICAL
ELECTRICAL
GAS**

**WANTED BY RAPIDLY GROWING ELECTRIC AND GAS COMPANY ON EAST COAST**

**Experienced Engineers required in Engineering Department for expansion program covering Steam Power Plants, Electric Generation, Transmission and Substations and Gas Production and Transmission. Jobs offer permanent employment with ample advancement opportunities for men with ability and initiative.**

**Pleasant congenial suburban community in close proximity to a Metropolitan Area.**

***Write giving full particulars of education, experience, and salary to:***

**BOX CA-4300**

***When required personal interviews will be arranged for evenings or Saturdays.***

**RATES** Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

### DEVELOPMENT ENGINEER

30–50, graduate, for finding, developing and applying ideas for nonferrous metal products in a wide variety of fields. Must have sound technical background and pertinent experience. A good opportunity to show initiative, resourcefulness, imagination, cost consciousness and co-operation. Location New England. Considerable travel involved. Salary according to experience and ability.

Address CA-4336, % "Mechanical Engineering."

### WATCH ENGINEER

for 600,000 lb./hr. boiler plant of a large factory in Western Maryland. Applicant must be under 40 years of age and experienced in the operation of large pulverized coal and underfeed stokered boilers. Rotating shift work. Applicant must have a high school education. Salary open. Pension and insurance benefits.

Address CA-4322, % "Mechanical Engineering."

### MECHANICAL ENGINEER

Project Engineer for Engineering Department, medium sized pharmaceutical and chemical manufacturing company, Central N. Y. State. Prefer male, 25 to 30 years of age, with B.S. in Mechanical Engineering. Will consider qualified E.E. Must have 2-4 years' experience in plant engineering, some knowledge of steam plants, machine shop practice, industrial distribution circuits and preventative maintenance.

**Please send complete resumé to
Personnel Department,
The Norwich Pharmacal Company
17 Eaton Avenue, Norwich, N. Y.**

### MECHANICAL ENGINEER

We are looking for a man with sound scientific training, preferably a Ph.D. degree, who combines imagination with good commercial judgment to join a small advance development group. He will be associated with physicists, physical chemists and electronic engineers and will be called upon to present and evaluate ideas for development into commercial products. Mental flexibility and broad general interest will be important requisites. The person we are looking for must be capable of presenting his thoughts well either in reports or oral form.

Please send us a resumé of your qualifications, experience and salary expected. Replies will be treated confidentially.

**Clevite-Brush Development Company
Division of Clevite Corporation
3311 Perkins Avenue
Cleveland, Ohio**

Operating Units of Clevite Corp. are Cleveland Graphite Bronze Company, Brush Electronics Company, (formerly Brush Development Company), Harris Products Company, Transistor Products, Inc.

### MECHANICAL ENGINEERS THE FRANKLIN INSTITUTE LABORATORIES FOR RESEARCH AND DEVELOPMENT

**offer**

Excellent opportunities in the fields of hydraulics, bearings, friction and wear, stress analysis, dynamics, heat transfer, design and development of specialized machinery.

Responsible positions available for research engineers, test engineers, development engineers and designers.

Salary commensurate with ability and experience.

*Send Resumé and Salary Desired to:*

**Personnel Department
THE FRANKLIN INSTITUTE
20th & Benjamin Franklin Parkway
Philadelphia 3, Pa.**

### DESIGN ENGINEER

Graduate mechanical engineer, preferably with 1-4 years' experience in the design, manufacture, or testing of machinery, for work on 1 to 500 h.p. electric motors and related items. Motor experience not necessary. Knowledge of mechanical drawing, materials of construction, strength of materials, metallurgy, lubrication, welding, air flow, heat transfer, and general shop practice helpful, but applicant will not be expected to have had experience in all of these subjects.

There is also an opening for a good career draftsman who enjoys layout and design work.

Howell is located 50 miles west of Detroit, within a short drive of Lansing and Ann Arbor, in the lake region of lower Michigan, and offers many rural living advantages.

Write fully about yourself to:

**R. P. Ballou, Chief Engineer
Howell Electric Motors Co.
Howell, Michigan**

*Additional Opportunities are offered in the display advertisements— on pages 60, 62, 63, 128, 130*

*Why Lockheed in California offers*

# better careers for engineers

## 1 *Diversified Production*

Fighters, bombers, trainers, cargo transports, radar search planes and huge luxury airliners are rolling off Lockheed assembly lines. Twelve models are in production.

This capacity to design and build such a wide range of aircraft is important. It means Lockheed offers you broader scope for your ability. It means you have more opportunity for fresh, creative thinking—because Lockheed's thinking covers *all* phases of aeronautical engineering. It means your future is not chained to any particular type of plane—because Lockheed is known for leadership in virtually *all* types of aircraft. It also is one of the reasons Lockheed has an unequalled record of production stability, year after year.

## 2 *Diversified Development Projects*

The most diversified development program in Lockheed's history is under way—and it is still growing. It means more and better career engineering opportunities for you—now and in the future. It means your career can grow with a company that is growing on *all* aviation fronts.

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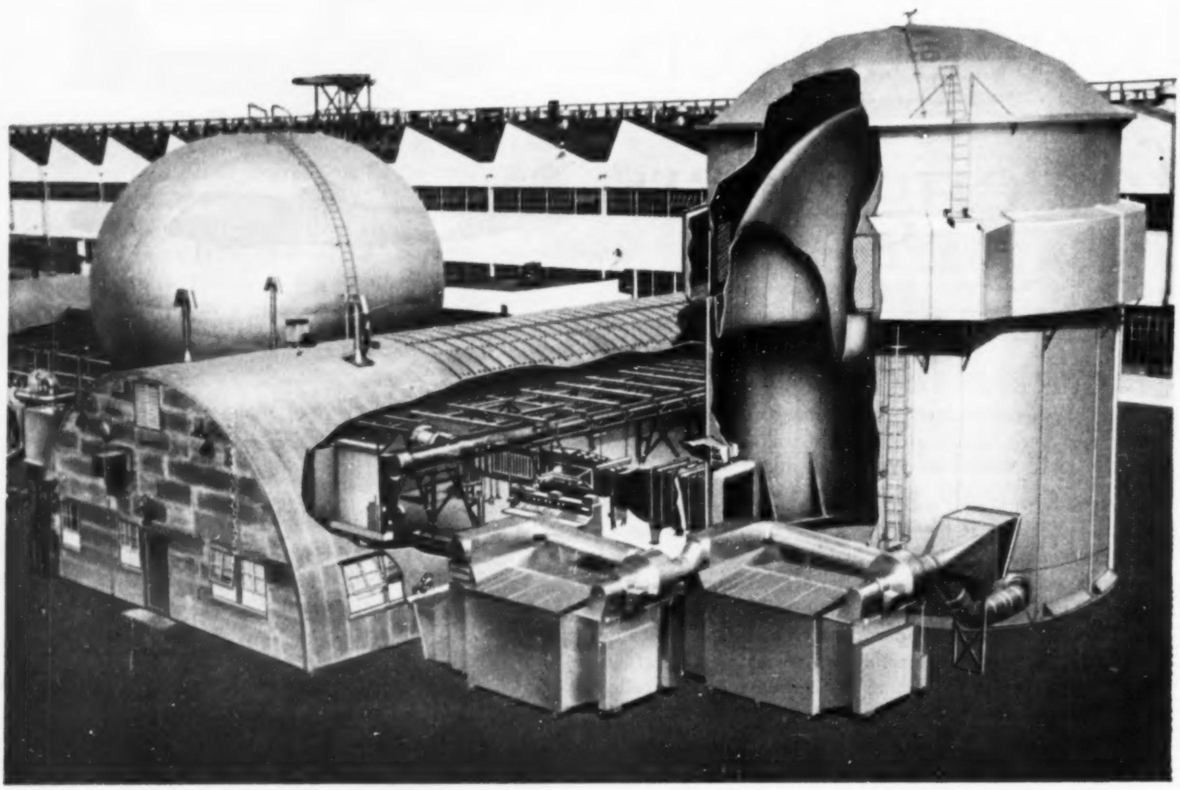

## AT NORTH AMERICAN AVIATION

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Typical of this equipment is the world's largest privately owned supersonic wind tunnel (above) at North American Aviation. To test rocket and missile models, this tunnel simulates speeds over 4,000 miles per hour. The foresight to plan ahead and to develop such outstanding engineering facilities explains North American's leadership in guided missile development.

North American's Missile and Control Equipment Operations has outstanding career opportunities for scientists and engineers. If you want to work on vital, advanced projects in aerodynamics, airframe design, structures and stress, propulsion systems, rocket engines, electro-mechanical and automatic control equipment, flight test instrumentation and associated operations, a brighter future is yours at North American.

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# Seven Pages of "OPPORTUNITIES" This Month...139-145

## MECHANICAL ENGINEERS . . .

This new division of the Bendix Aviation Corporation in York, Pennsylvania has a bright future, and this is your opportunity to get in on the ground floor with excellent possibilities for advancement.

Our work in producing new electronic products involves the need for Mechanical Engineers at several levels of technical accomplishment.

. . . And at the Bendix York Division you benefit from high wages, paid vacations and holidays and ideal living conditions in a beautiful suburban area.

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## SALES ENGINEERS

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Address CA-4339, % "Mechanical Engineering."

## MECHANICAL ENGINEERS

We need two graduate M.E.'s with job shop experience for supervisory positions at our shop, rebuilding and manufacturing production machinery in a northern Illinois community. We have up to date benefit plans and excellent working conditions. Replies will be treated confidentially and should contain personal information, education and experience.

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ENGINEERS—college positions. All sections U.S., all fields of engineering. Openings for B.S., M.S. and Ph.D's. Excellent salaries. Send pictures and qualifications to Cline Teachers Agency, Box 607, East Lansing, Mich.

MEDICAL ENGINEERING—Combination advanced degree work in Johns Hopkins Engineering School; instrument design and execution; theoretical and experimental analysis of complex vibrations problem in ballistocardiography project. Write full qualifications, experience, salary level, to Dr. S. A. Talbot, Johns Hopkins Hospital, Baltimore 5, Md.

PRODUCTION MANAGER—Small, rapidly growing manufacturer of industrial reinforced plastic, located on Long Island, needs a graduate mechanical engineer with two to three years' production experience; preferably under 30; will have complete responsibility and authority in setting up production line, systems, procedures, etc. Familiarity with tool and die operations, materials field, and mold design desirable. Opportunity unlimited. Please send complete resumé and salary requirements. Address CA-4338, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Plant engineering. Pharmaceutical manufacturer, No. N.J. Fine grinding and steam plant experience desirable. Reply in full detail. Address CA-4359, care of "Mechanical Engineering"

PROJECT ENGINEERS—Solidly established company located in upstate New York in basic non-defense industry seeking several project engineers to work on layout and installation of food processing equipment; also plant alterations. Graduate engineers preferred but will consider basic engineering training and practical experience in lieu of degree. Please send full resumé listing education, experience and salary requirements. Address CA-4355, care of "Mechanical Engineering."

A SALESMAN for a nationally known Pipe Fabricating and Erecting Company. College graduate in Engineering, plus knowledge of the piping industry required. Person desired: Approximately 35 years of age and willing to do extensive traveling. Good salary and expenses. Address CA-4298, care of "Mechanical Engineering."

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or that may be of interest to you.

# Seven Pages of "OPPORTUNITIES" This Month...139-145

## POSITIONS WANTED

MECHANICAL ENGINEER—BSME. Age 26. 2 years' Army Engineers, 2 years' industrial experience equipment design and testing, report writing, process piping and valving design. Desire a creative position in manufacturing or mining. Western U.S. preferred. Will be available upon release from service in June 1953. Address CA-4344, care of "Mechanical Engineering."

MECHANICAL ENGINEER—48, married, 14 years' Development, and 13 years' Broad Patent Experience. Desires permanent position with medium size aggressive firm in engineering or managing Patent Dept., where outside Counsel is retained. Now with large firm on West Coast. Address CA-4345, care of "Mechanical Engineering."

MECHANICAL ENGINEER—desires foreign employment preferably in Europe or Latin America. Primarily interested in supervisory or administrative position. 15 years' heavy experience in power, mining, construction and general engineering, all phases. Age 34, married, one child. Previous Latin American experience. Spanish speaking. Presently employed by large construction company. Available on short notice. Excellent references. Inquiries invited. Address CA-4346, care of "Mechanical Engineering."

MECHANICAL ENGINEER—28, single, veteran, MS, Registered PE. Desires foreign position. 6 years' experience steam power plants, design, procurement, economic studies, project engineer, with consulting firm. Knowledge piping, instrumentation and controls, steam equipment. Address CA-4348, care of "Mechanical Engineering."

REGISTERED ENGINEER—38, desires position medium sized Phila. Co. with exacting standards and intestinal fortitude to let employee exercise initiative. Process and Ceramic Equipment, Development, Production, Automatic Machinery. Address CA-4353, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Graduate—Age 30, married—Six years' Chemical Industry experience in Plant and Project Engineering, including two years' high pressure work. Desires responsible position in Chemical Process Industry. Present salary $6700. Address CA-4358, care of "Mechanical Engineering."

GRADUATE EE—32. 3 years' maintenance, operation, administration. Varied experience personnel handling. Desires challenging position in manufacturing or plant engineering. Know Spanish. Locate anywhere. Address CA-4354, care of "Mechanical Engineering."

## INVENTIONS

WRITE for information about service for selling inventions. Patent Engineering Development Co., 617 Pioneer American Building, Houston, Texas.

## BOOKS FOR SALE

Stop wasting money. Read how you can benefit by establishing Preventive Maintenance. Send $1.50 for the Preventive Maintenance Manual. Box 224, West Hartford 7, Conn.

See Advertisements on Preceding Pages

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This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

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***READ the* CLASSIFIED ADVERTISEMENTS *appearing in this section each month.***

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*An announcement in this section will acquaint others with your specialized practice.*

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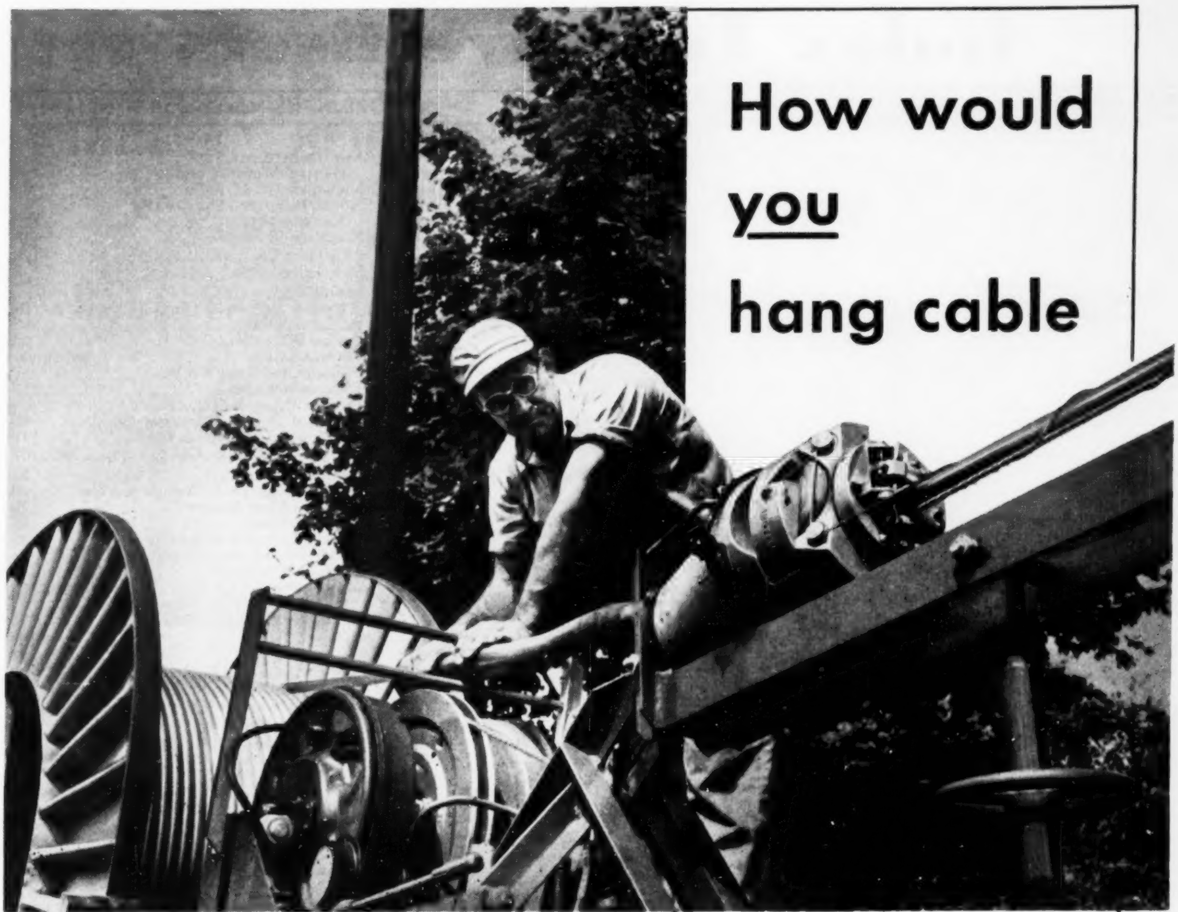
The above consultants are available
to work out solutions
to your engineering and management problems

# How would *you* hang cable



*Cable lasher appears to right of workman. As the cable and supporting strand feed through, the machine rotates, binding them together with steel lashing wire. Meanwhile, a winch hauls the lashed cable into position.*

# ...by the mile?

It is a job your telephone company faces every day. Thousands of miles of cable go up each year—all secured to steel strand running from pole to pole. The best way to secure cable is to *lash* it to the strand with a spiral binding of wire.

One way to do this is to raise cable and strand separately, then lash them together by a rotating machine pulled along by workmen on the ground. This produces a strong, tight support for the cable. But each pole has to be climbed as many as four times. So Bell Laboratories engineers devised an easier way.

Now, lashing can be done *on the ground* so that cable, strand and lashing wire may be pulled into position as a complete assembly. Usually workmen need make only two trips up each pole.

For telephone users, the new way means that cable can be installed faster, while costs are kept down. It shows again how work at Bell Telephone Laboratories improves each part of your telephone system.

## Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN MECHANICAL ENGINEERING

# Index To Advertisers

**KEEP INFORMED—Pages 41-71** | **June, 1953** | **OPPORTUNITIES—(classified ad Pages) 139-145**

*** The asterisk indicates that firm also has product catalog in the 1953 ASME Mechanical Catalog and Directory**



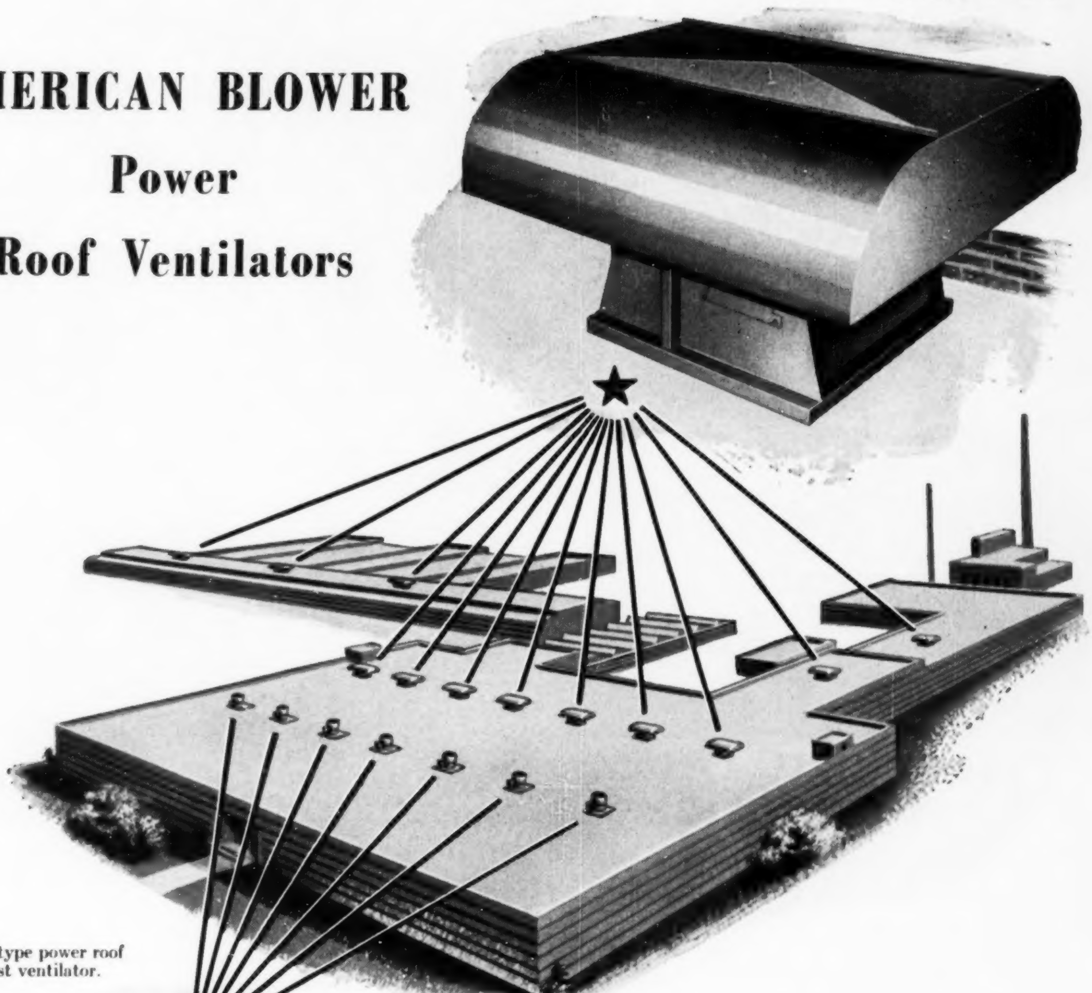
**CONSULTING SERVICE . . . Page 145**



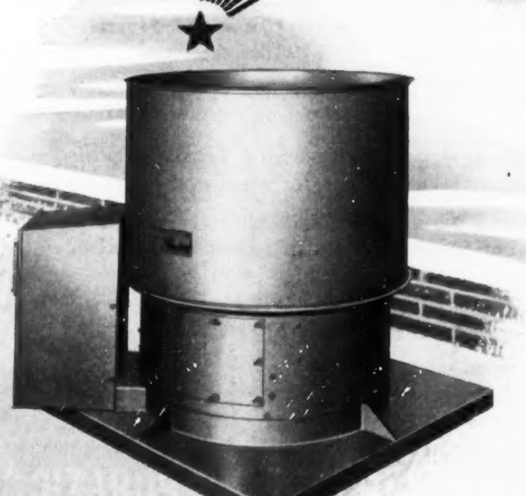
## Advertisers in Previous 1953 issues but not in this issue

Hood type power roof exhaust
or supply ventilator.

# AMERICAN BLOWER
## Power
## Roof Ventilators



Upblast type power roof
exhaust ventilator.



American Blower *power* roof ventilators give you the advantages of balanced ventilation, without the uncertainties of gravity units or the expense of a central system.

They're quickly and easily installed on all types of roofs. No extensive duct work is required; no valuable floor space is wasted. Use single units for spot ventilation; several units for large area coverage. American Blower power roof ventilators, supply or exhaust, are available in a wide range of capacities. They are designed to furnish balanced ventilation to industrial plants and commercial buildings.

Ask our nearest branch office for data.

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CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary corporation

**AMERICAN BLOWER**

YOUR BEST BUY IN AIR HANDLING EQUIPMENT

*Serving home and industry:* AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

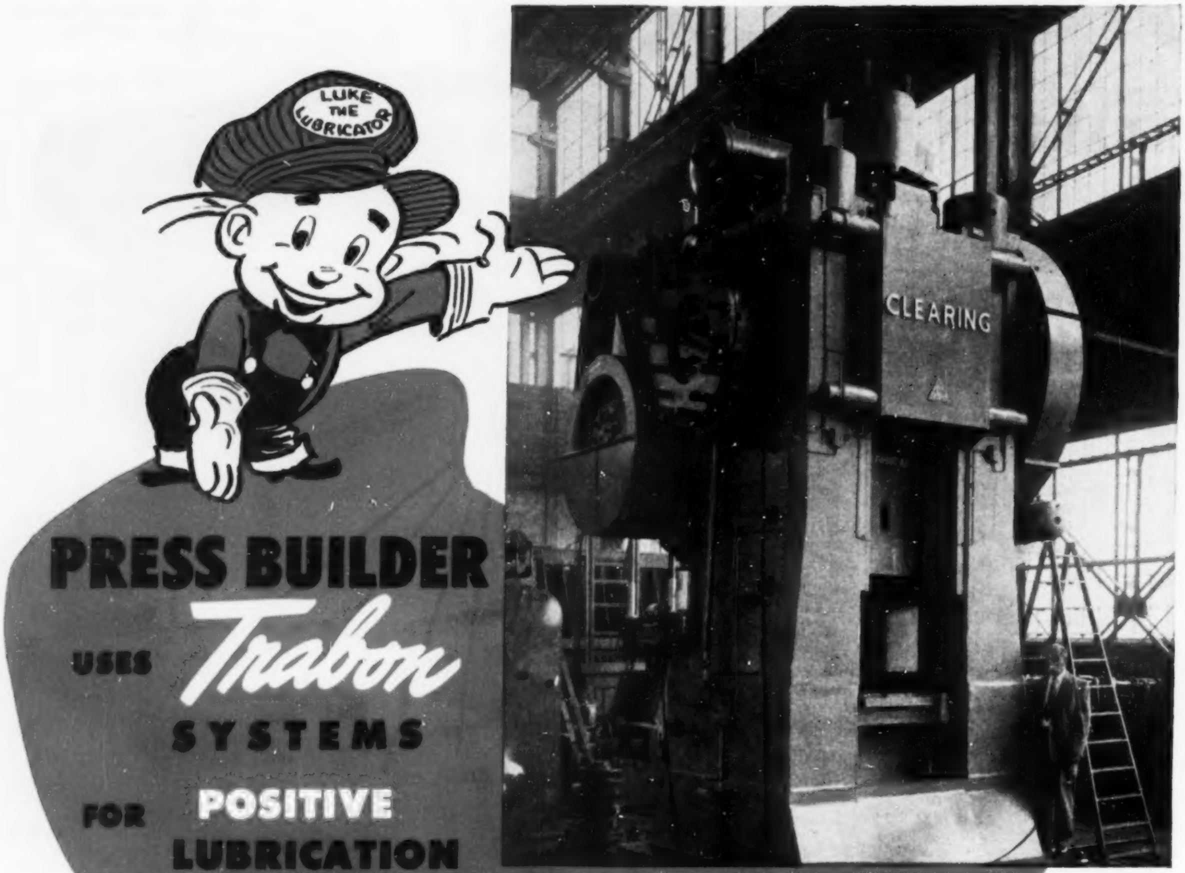



Photo courtesy Clearing Machine Corp., Chicago

## this has a BEARING on the subject

TRABON *automatic* lubrication on this Clearing forging press lubricates 36 bearing points while the press operates under full load. This completely trouble-free system has eliminated bearing burnouts and costly shutdowns.

A TRABON system on *your* equipment will do the same job efficiently, economically and positively.

Remember, it's impossible to under-lubricate or skip a bearing with a TRABON positive system . . . a single indicator at the pump tells the operator when every bearing is properly lubricated.

Fully hydraulic . . . economical . . . for oil or grease . . . safe . . . completely sealed.

***There are more Trabon Automatic Lubrication Systems in use than all other makes!***

Write for Bulletin No. 529

**Trabon ENGINEERING CORPORATION**
1814 E. 40th STREET • CLEVELAND 3, OHIO
*Oil and Grease Systems*

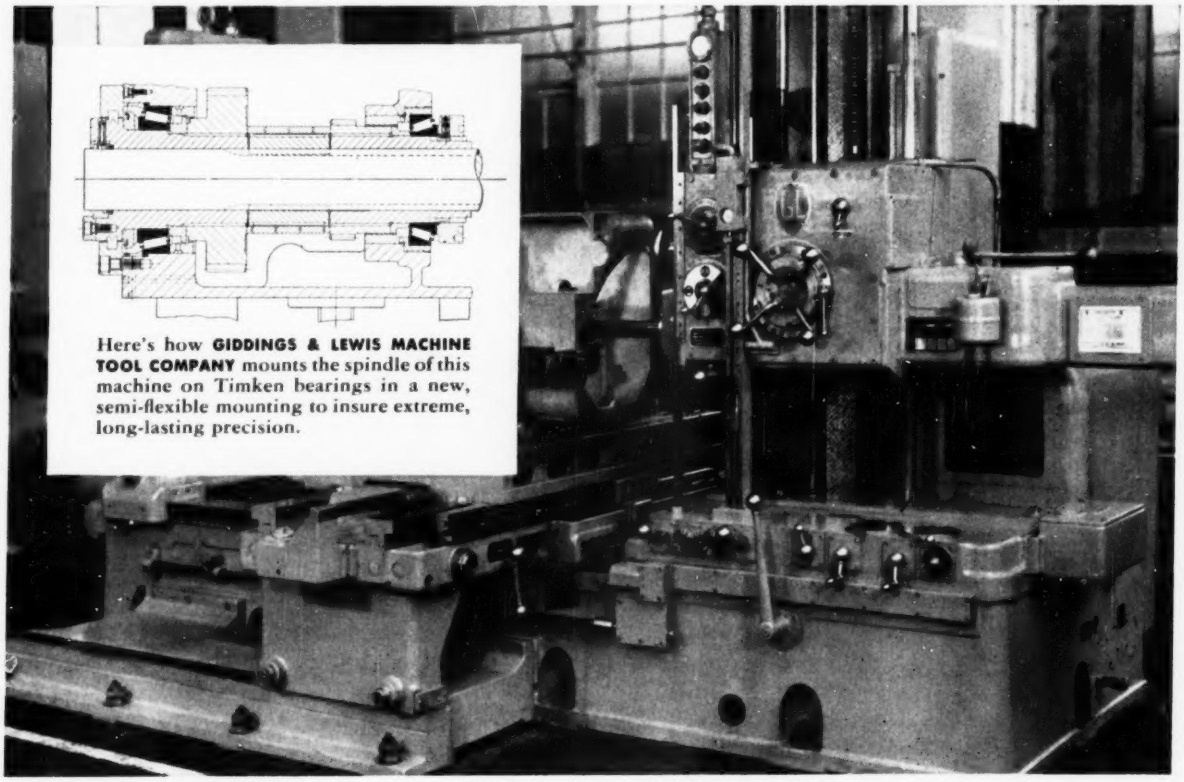
# Gets high-speed spindle accuracy with TIMKEN® bearings in new semi-flexible mounting

TO insure high-speed spindle accuracy under varying conditions of speed, temperature and loading, Giddings and Lewis mounts the spindle of its 300 horizontal boring, drilling and milling machine on Timken® precision bearings in a new semi-flexible mounting.

The new semi-flexible mounting was developed by engineers of The Timken Roller Bearing Company specifically to meet the requirements of higher spindle speeds. In this new mounting, the rear spindle bearing is mounted in a carrier, one end of which has a slight clearance in the housing while the other end has a tight fit (see diagram). The clearance between carrier and housing permits radial expansion to take place without excessive preloading of the bearings. The result is uniformly high spindle precision from the beginning to the end of every job.

The new semi-flexible mounting has been thoroughly proved in tests and in machine tools now in operation. For full information, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best.*



Here's how **GIDDINGS & LEWIS MACHINE TOOL COMPANY** mounts the spindle of this machine on Timken bearings in a new, semi-flexible mounting to insure extreme, long-lasting precision.

# TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

**TAPERED ROLLER BEARINGS**

**MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!**

Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

**NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▱ BEARING TAKES RADIAL ↓ AND THRUST → ← LOADS OR ANY COMBINATION**